UNIVERSITY OF BRISTOL.

THE ANNUAL REPORT

OF THE

Agricultural and Horticultural Research Station

(THE NATIONAL FRUIT AND CIDER INSTITUTE),

LONG ASHTON, BRISTOL,

1913.

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CONTENTS.

INTRODUCTION.

The Department of Agricultural and Horticultural Research of the University of Bristol was established in the summer of 1912. The primary function of the Department is to conduct research in Agriculture and Horticulture. For this purpose the National Fruit and Cider Institute has been associated with it: and the headquarters of this body at Long Ashton have been taken over and developed to form the Research Station of the Department. This Institution has been selected by the Board of Agriculture and Fisheries as one of the Research Stations to be supported under its Scheme for the Development of Agricultural Research: and the special subjects of work allotted to it are Fruit Culture and the Practical Treatment of Plant Diseases.

The University of Bristol has also been selected by the Board of Agriculture and Fisheries to serve as the Advisory Centre for the West Midland Province (including the counties of Gloucester, Hereford, Somerset, Wiltshire and Worcester), in connection with the Scheme for the Provision of Technical Advice for Farmers: and the work coming under this head is undertaken by the Department on behalf of the University.

The affairs of the Department are administered by a Joint Committee constituted of representatives of the University and the National Fruit and Cider Institute. Under the arrangement entered into between these two bodies the Director of the Institute acts as Head of the Department; and the organisation and direction of its work are under his control.

The other members of the Research Staff already appointed are Mr. C. T. Gimingham, F.I.C., Chemist, Mr. O. Grove, Oenologist, and Mr. A. H. Lees, M.A., Plant Pathologist. In due course a mycologist, and, possibly, a plant physiologist and pomologist also will be added to the staff.

The original buildings of the Institute at Long Ashton being totally inadequate, considerable additions were necessary and have been made during the year. These have been erected on land purchased from the Ashton Court Estate in 1912. The land thus acquired amounts to ten and a half acres, and on it were already situated the previously existing buildings of the Institute and a pair of cottages, one of which has been converted into a foreman's residence, and the other into offices and temporary laboratories.

The chief addition has been the block of buildings comprising the new laboratories. One of the greatest difficulties in the earlier period of the Institute's history had been the insufficiency of the laboratory accommodation and the inadequacy of its equipment. The new building will remove that obstacle. It is divided into a series of separate laboratories, each of which is devoted to a special subject. It includes rooms for chemistry, entomology, fermentation work, mycology, and plant physiology, as well as an assistant's laboratory, incubator room, library and committee room, dark room, museum and lecture room, heating basement, stores loft and basement, and the Director's laboratory and private room. Attached to it is a small greenhouse for experimental purposes. Since there is no public supply of gas available at Long Ashton, it has been necessary to instal a gas-making plant and gas-holders, the kind of gas selected for use being oil gas. A separate building, situated close to the laboratories, has had to be provided for this purpose. Fortunately it has not been difficult to obtain an adequate water supply, connection having been made with the Bristol Waterworks Company's high pressure main from the Barrow reservoirs, which passes close to the building. The necessary laboratory fittings have now been added, and the staff were able to begin work in the building at the beginning of 1914. The building has been wired for electric current for lighting and laboratory use: and in due course provision will be made for a supply of current. The building, which is a one-storey structure, is situated on a bank at the south side of the young cider orchard, above which it stands sufficiently high for the light not to be interfered with as the trees increase in size. It is 150 feet long and 35 feet wide, with a projecting wing at the east end.

For several seasons the experimental cider work had been seriously hampered and curtailed on account of inadequate accommodation and equipment. A large new wing, which will be available for next season's work, has now been added to the existing cider buildings. It is a three-storey building, the upper floor of which will serve as a fermentation room, the ground-floor as a machinery room, and the three-parts-underground basement as a storage cellar. The mill and press remain undisturbed in the old part of the building; but the new machinery, including carbonating, bottling, and other plant, will be placed in the new wing. Certain alterations to the old buildings will be made before the next cider-making season to provide, among other things, better accommodation for the storing and washing of the cider fruit, and a small fermentation room, the temperature of which can be under control.

Other buildings which have been erected include a residence for the Manager, a three-quarter span vinery, 75 feet long, and an orchard house for experimental work on fruit trees in pots, 60 feet long by

25 feet wide. A walled-in garden, about one acre in area, has been arranged, and it is in this that the greenhouses are situated. The garden will be used mainly for the cultivation of seedlings and for the purpose of experimental work which needs special protection or which for other reasons cannot satisfactorily be conducted in the open plantations.

More space being required for experimental market fruit plantations, it was decided to sacrifice the old cider orchard, which had for some time ceased to bear profitable crops on account of the age and defective condition of the trees. The latter have now all been removed and the ground has been cultivated. An acre plantation of small fruits, including black and red currants, gooseberries, raspberries, strawberries, loganberries, and the more recent introductions related to the latter, was planted last winter; and half an acre has been devoted to a collection of strains of crab, free, and Paradise stocks obtained from practically all the leading fruit nurserymen in the country and used by them for the propagation of apples. The primary object is to test the value of the individual strains with the view of selecting the most useful for general propagation purposes. The remainder of the ground is being devoted to a collection of half standard plums and additional plots of small fruits.

In previous years the National Fruit and Cider Institute has issued an Annual Report containing an account of the research and other work carried on during the year. Owing to the association between the Department and the Institute, by which the work of the latter is to a great extent merged into that of the former, it has been decided to issue annually a Report of the Station, which will so far as the experimental work is concerned fill the place of the old Annual Report of the Institute. This, the first number of the Report, contains short reports on various investigations in progress at the Station during 1913. In certain instances more complete accounts have been or are being published in various scientific periodicals, and some of the matter has already appeared in the Report of the Institute contained in the Journal of the Bath and West Society for 1913.

SINGLE VARIETY CIDERS AND PERRIES, 1912-13.

By B. T. P. Barker and Otto Grove.

Following the usual practice, ciders and perries were made during the season 1912–13 on a practical scale in the cider house from several different varieties of cider and, perry fruit in order to test the vintage qualities of those kinds and, in certain cases, to ascertain the extent of variation from season to season and the influence of the soil on which the fruit was grown and of other local conditions.

In each case the pomace was pressed immediately after milling, and allowed to ferment naturally in cask, without keeving, until the specific gravity had dropped to 1·030–1·040, when the liquor was filtered. In most instances a second filtration was necessary.

Details of the characters of the individual ciders are appended. A few preliminary comments on the general character of the ciders of that season may be of some interest.

As was expected, after the cold, sunless, and wet summer of 1912 the vintage quality of the fruit was poor; but the improvement in the weather conditions during the autumn undoubtedly had some beneficial effect, and the situation was thus partially saved. The comparatively low specific gravities in the accompaying tables indicate the general shortage of sugar in the fresh juices. It was the first season since the establishment of the Institute that the average gravity fell below 1·050. There were a few outstanding instances which are difficult to account for. Thus, the high gravities of Yellow Styre and Moorcroft, two varieties of usually good but not superlatively high gravity, and the abnormally low gravities of Dymock Red and Broadleaf Norman, two kinds generally above, rather than below, the average, may be instanced. Also the curious cases of the high gravity of No. 4 Oldfield as compared with the low gravities of Nos. 1, 2, and 3, of the same sort, and the unusually low gravity of Kingston Black No. 5, as compared with the average of the remainder of that sort are interesting.

It would not have been surprising to find the acidities ranging decidedly high; and indeed for the sweet and bitter-sweet apples that proved generally to be the case. But where perhaps the most marked increase above the normal might have been expected, viz., in the sharp varieties of apples, the general tendency was towards a figure below the average. The Kingston Blacks generally, Cap of

Liberty, and Skyrme's Kernel were conspicuous examples of that tendency.

The tannins practically throughout were on the low side, although except in some of the perry pears and bittersweet apples not markedly so. Several of the bitter-sweet results were abnormally low, the amount failing to reach the normal lower limit (·2 per cent.) for the class. The tannins of the sharp apples on the other hand were by no means strikingly low.

The rates of fermentation were generally on the high side according to expectation, but otherwise did not present any features of special interest.

As regards the ciders and perries themselves there was a general lack of body and fruity character, examples of special merit being conspicuous by their absence. On the other hand there were few really unpleasant kinds: and the general conclusion was that they were a fairly pleasant lot, mainly on the thin side and more or less devoid of special character.

The most striking feature noted was the unusually marked susceptibility to acetification after the primary fermentation had ceased. The latter, although more rapid than usual, appeared to exhaust itself very quickly, unlike that of rapid examples in other seasons, which generally remained persistent. As a result the amount of acetification of draught cider during the summer of 1913 and also the prevalence of "fliers" in the bottled cider are much greater than the normal.

The vintage of 1912–13 therefore was one which yielded few really good ciders and perries likely to improve with age; and the majority were probably at their best during the spring and early summer following making. These features of early maturity and poor keeping quality were therefore exactly the opposite of those of the 1911–2 vintage.

CIDERS.

Sharp Varieties. (Juice containing normally more than ·45 per cent. malic acid).

Bickington Grey (Littlehempston, Devon).

Analysis of fresh juice, 11th November, 1912:

Specific gravity	1·047
Malic Acid	1·00%
Tannin	·146%

Weight of fruit, 1,032lbs.
Yield of juice, 722lbs.
Average daily fall in specific gravity at 28°C., ·0077.
Filtered 19th November, 1912. Specific gravity, 1·031.
Specific gravity in bottle, 1st May, 1913, 1·022.

Remarks: A medium sweet cider of pronounced acidity and good body. Flavour and aroma very good.

Too sharp alone, but excellent for blending. This is the first time of trial with this sort, which promises to make a very useful addition to the list of sharp varieties of the Cap of Liberty type.

Butterbox (Barton, Devon).

Analysis of fresh juice, 6th December, 1912:
Specific gravity .. .. .. 1·046
Malic Acid .. .. .. ·53%
Tannin .. .. ·152%
Weight of fruit, 1,130lbs.
Yield of juice, 691lbs.
Average daily fall in specific gravity at 28°C., ·005.
Filtered 30th December, 1912. Specific gravity, 1·022.
Specific gravity in bottle, 1st May, 1913, 1·011.

REMARKS: Thin, dry, medium sharp cider. Aroma moderate, flavour inferior.
Of moderate use for blending.

Cap of Liberty (South Petherton, Somerset).

Analysis of fresh juice, 26th November, 1912:
Specific gravity .. .. .. 1·045
Malic Acid .. .. .. ·75%
Tannin .. .. ·170%
Weight of fruit, 1,135lbs.
Yield of juice, 829lbs.
Average daily fall in specific gravity at 28°C., ·0048.
Filtered 27th December, 1912. Specific gravity, 1·022.
Specific gravity in bottle, 1st May, 1913, 1·016.

REMARKS: Sharp cider of medium body and sweetness, with excellent flavour and aroma.
Very useful for blending, but rather too brisk alone.

Cherry Pearmain (Marden, Hereford).

Analysis of fresh juice, 22nd November, 1912:
Specific gravity .. .. .. 1·043
Malic Acid .. .. .. ·38%
Tannin .. .. ·142%
Weight of fruit, 721lbs.
Yield of juice, 507lbs.
Average daily fall in specific gravity at 28°C., ·0042.
Filtered 29th November, 1912. Specific gravity, 1·038.
Specific gravity in bottle, 1st May, 1913, 1·021.

REMARKS: A cider of medium sweetness, but of disappointing quality. Flavour and aroma being slightly tainted. Much inferior to previous ciders made from this apple.
Indifferent for blending and unfit for use alone.

Dymock Red (Ledbury, Hereford).

Analysis of fresh juice, 16th November, 1912:
Specific gravity .. .. .. 1·038
Malic Acid .. .. .. ·42%
Tannin .. .. ·156%
Weight of fruit, 1,228lbs.
Yield of juice, 886lbs.
Average daily fall in specific gravity at 28°C., ·0052.
Filtered 3rd December, 1912. Specific gravity, 1·023.
Specific gravity in bottle, 1st May, 1913, 1·012.

REMARKS: Thin, dry cider of medium acidity, flavour and aroma inferior.
Quality too poor for use alone and indifferent for blending. The result for this variety is distinctly below the average.

Fair Maid of Taunton (Martock, Somerset).

Analysis of fresh juice, 20th November, 1912:
- Specific gravity .. .. .. 1·047
- Malic Acid .. .. .. ·55%
- Tannin .. .. ·192%

Weight of fruit, 1,100lbs.
Yield of juice, 845lbs.
Average daily fall in specific gravity at 28°C., ·0042.
Filtered 29th November, 1912. Specific gravity, 1·033.
Specific gravity in bottle, 1st May, 1913, 1·021.

REMARKS: A cider of moderate sweetness and acidity, somewhat approaching the Devon type. Aroma and flavour fairly agreeable, but lacking in character.

Can be used alone but better blended with a cider of more decided type.

Foxwhelp (Ledbury, Hereford).

Analysis of fresh juice, 16th November, 1912:
- Specific gravity .. .. .. 1·046
- Malic Acid .. .. .. ·68%
- Tannin .. .. ·138%

Weight of fruit, 1,092lbs.
Yield of juice, 780lbs.
Average daily fall in specific gravity at 28°C., ·0048.
Filtered 4th December, 1912. Specific gravity, 1·028.
Specific gravity in bottle, 1st May, 1913, 1·020.

REMARKS: A medium sweet brisk cider, flavour characteristic and fairly good. Aroma deficient.

Of moderate quality for use alone, and very fair when suitably blended. This cider probably requires age to develop the true Foxwhelp character.

Frederick (Newton Court, Monmouth).

Analysis of fresh juice, 12th November, 1912:
- Specific gravity .. .. .. 1·047
- Malic Acid .. .. .. 1·01%
- Tannin .. .. ·110%

Weight of fruit, 1,084lbs.
Yield of juice, 739lbs.
Average daily fall in specific gravity at 28°C., ·009.
Filtered 28th November, 1912. Specific gravity, 1·024.
Specific gravity in bottle, 1st May, 1913, 1·013.

REMARKS: A very sharp dry cider of good aroma and flavour.

Too sharp for use alone, but valuable for blending with sweet and bittersweet types.

Kingston Black (Ashill, Somerset).

Analysis of fresh juice, 13th November, 1912:
- Specific gravity .. .. .. 1·052
- Malic Acid .. .. .. ·55%
- Tannin .. .. ·168%

Weight of fruit, 1,115lbs.
Yield of juice, 832lbs.
Average daily fall in specific gravity at 28°C., ·0051.
Filtered 11th December, 1912. Specific gravity, 1·027.
Specific gravity in bottle, 1st May, 1913, 1·020.

REMARKS: A medium sweet cider of some briskness. Aroma and flavour very fair.

Kingston Black (Tewkesbury, Gloucester).

Analysis of fresh juice, 15th November, 1912:
- Specific gravity .. .. .. 1·052
- Malic Acid .. .. .. ·47%
- Tannin .. .. ·162%

Weight of fruit, 1,192lbs.
Yield of juice, 857lbs.
Average daily fall in specific gravity at 28°C., ·0032.
Filtered 19th December, 1912. Specific gravity, 1·032.
Specific gravity in bottle, 1st May, 1913, 1·028.

REMARKS: A sweet, fairly brisk, cider of pleasant flavour and aroma. One of the best of Kingston Black ciders of this season.

Kingston Black (Tewkesbury, Gloucester).

Analysis of fresh juice, 4th December, 1912:
- Specific gravity .. .. .. 1·043
- Malic Acid .. .. .. ·35%
- Tannin .. .. ·142%

Weight of fruit, 1,041lbs.
Yield of juice, 747lbs.
Average daily fall in specific gravity at 28°C., ·0047.
Filtered 30th December, 1912. Specific gravity, 1·026.
Specific gravity in bottle, 1st May, 1913, 1·020.

REMARKS: A fairly sweet cider, less brisk than usual with this variety, and of very fair flavour and aroma.

Kingston Black (Ripple, Somerset).

Analysis of fresh juice, 3rd December, 1912:
- Specific gravity .. .. .. 1·054
- Malic Acid .. .. .. ·44%
- Tannin .. .. ·150%

Weight of fruit, 1,242lbs.
Yield of juice, 857lbs.
Average daily fall in specific gravity at 28°C., ·0058.
Filtered 3rd January, 1912. Specific gravity, 1·029.
Specific gravity in bottle, 1st May, 1913, 1·020.

REMARKS: A medium sweet, somewhat thin cider. Flavour and aroma fair, but below the average for the variety.

Kingston Black (Oldbury-on-Severn, Gloucester).

Analysis of fresh juice, 16th December, 1912:
- Specific gravity .. .. .. 1·038
- Malic Acid .. .. .. ·29%
- Tannin .. .. ·136%

Weight of fruit, 1,019lbs.
Yield of juice, 727lbs.
Average daily fall in specific gravity at 28°C., ·0033.
Filtered 1st January, 1913. Specific gravity, 1·022.
Specific gravity in bottle, 1st May, 1913, 1·015.

REMARKS: A thin, medium dry cider, lacking in briskness, much below the average for the variety, probably the fruit in this case was stored too long before milling.

Kingston Black (White Lackington, Somerset).

Analysis of fresh juice, 3rd December, 1912:
Specific gravity .. .. .. 1·054
Malic Acid .. .. .. ·43%
Tannin .. .. ·148%
Weight of fruit, 1,079lbs.
Yield of juice, 799lbs.
Average daily fall in specific gravity at 28°C., ·0057.
Filtered 1st January, 1913. Specific gravity, 1·034.
Specific gravity in bottle, 1st May, 1913, 1·022.

REMARKS: A medium sweet cider of fair briskness. Flavour and aroma very fair.

Kingston Black (Norton Fitzwarren, Somerset).

Analysis of fresh juice, 3rd December, 1912:
Specific gravity .. .. .. 1·056
Malic Acid .. .. .. ·40%
Tannin .. .. ·120%
Weight of fruit, 977lbs.
Yield of juice, 727lbs.
Average daily fall in specific gravity at 28°C., ·0067.
Filtered 31st December, 1912. Specific gravity, 1·031.
Specific gravity in bottle, 1st May, 1913, 1·028.

REMARKS: A sweet, rather rich cider of moderate briskness. Flavour and aroma good.

Kingston Black (Marden, Hereford).

Analysis of fresh juice, 3rd December, 1912:
Specific gravity .. .. .. 1·049
Malic Acid .. .. .. ·45%
Tannin .. .. ·170%
Weight of fruit, 1,013lbs.
Yield of juice, 777lbs.
Average daily fall in specific gravity at 28°C., ·0048.
Filtered 31st December, 1912. Specific gravity, 1·021.
Specific gravity in bottle, 1st May, 1913, 1·011.

REMARKS: A thin, dry cider of inferior flavour and aroma, much below the standard for this variety.

Kingston Black (Tibberton, Gloucester).

Analysis of fresh juice, 5th December, 1912:
Specific gravity .. .. .. 1·048
Malic Acid .. .. .. ·44%
Tannin .. .. ·188%
Weight of fruit, 1,133lbs.
Yield of juice, 821lbs.
Average daily fall in specific gravity at 28°C., ·0024.
Filtered 31st December, 1912. Specific gravity, 1·032.
Specific gravity in bottle, 1st May, 1913, 1·030.

REMARKS: A sweet rich cider of medium briskness. Aroma and flavour very good. The best of the Kingston Black ciders made this season.

Kingston Black (Long Ashton, Somerset).

Analysis of fresh juice, 23rd November, 1912:
Specific gravity .. .. .. 1·046
Malic Acid .. .. .. ·43%
Tannin .. .. ·122%
Average daily fall in specific gravity at 28°C., ·0035.
Filtered 13th December, 1912. Specific gravity, 1·025.
Specific gravity in bottle, 1st May, 1913, 1·015.

REMARKS: A medium dry moderately brisk cider of inferior quality.

Kingston Black (Staplegrove, Somerset).

Analysis of fresh juice, 15th November, 1912:
Specific gravity .. .. .. 1·055
Malic Acid .. .. .. ·48%
Tannin .. .. ·144%
Weight of fruit, 896lbs.
Yield of juice, 631lbs.
Average daily fall in specific gravity at 28°C., ·0043.
Filtered 19th December, 1912. Specific gravity, 1·032.
Specific gravity in bottle, 1st May, 1913, 1·023.

REMARKS: A medium sweet, rather brisk cider, fair body and moderate flavour.

Lady's Finger (Long Ashton, Somerset).

Analysis of fresh juice, 26th October, 1912:
Specific gravity .. .. .. 1·046
Malic Acid .. .. .. ·65%
Tannin .. .. ·086%
Weight of fruit, 974lbs.
Yield of juice, 734lbs.
Average daily fall in specific gravity at 28°C., ·0102.
Filtered 31st October, 1912. Specific gravity, 1·025.
Specific gravity in bottle, 1st May, 1913, 1·017.

REMARKS: Thin, medium sweet cider of a rather brisk character; flavour and aroma characteristic of the variety, but poorer in quality than in preceding years.

Of moderate value for blending and too poor in quality for use alone.

Lambrook Pippin (East Lambrook, Somerset).

Analysis of fresh juice, 8th January, 1913:
Specific gravity .. .. .. 1·043
Malic Acid .. .. .. ·51%
Tannin .. .. ·215%
Weight of fruit, 1,100lbs.
Yield of juice, 872lbs.
Average daily fall in specific gravity at 28°C., ·0027.
Filtered 11th February, 1913. Specific gravity, 1·031.
Specific gravity in bottle, 1st May, 1913, 1·028.

REMARKS: A nice, moderately brisk sweet cider of excellent quality. Flavour and aroma superior.

This variety has fully maintained the high standard reached in previous seasons.

Pull Court Red (Tewkesbury, Gloucester).

Analysis of fresh juice, 15th November, 1912:
- Specific gravity .. .. .. 1·046
- Malic Acid .. .. .. ·76%
- Tannin .. .. ·158%

Weight of fruit, 1,163lbs.
Yield of juice, 840lbs.
Average daily fall in specific gravity at 28°C., ·0037.
Filtered 16th December, 1912. Specific gravity, 1·020.
Specific gravity in bottle, 1st May, 1913, 1·017.

REMARKS: A medium sweet cider resembling the Cap of Liberty type, but of inferior quality.
Moderately useful for blending, but too sharp alone.

Red Soldier (Tenbury, Worcester).

Analysis of fresh juice, 19th November, 1912:
- Specific gravity .. .. .. 1·052
- Malic Acid .. .. .. ·93%
- Tannin .. .. ·208%

Weight of fruit, 1,503lbs.
Yield of juice, 1,037lbs.
Average daily fall in specific gravity at 28°C., ·0058.
Filtered 24th December, 1912. Specific gravity, 1·022.
Specific gravity in bottle, 1st May, 1913, 1·012.

REMARKS: Very brisk, dry cider of fair aroma and clean flavour.
Useful for blending with sweet types.

Red Soldier (Tewkesbury, Gloucester).

Analysis of fresh juice, 11th November, 1912:
- Specific gravity .. .. .. 1·051
- Malic Acid .. .. .. ·76%
- Tannin .. .. ·166%

Weight of fruit, 875lbs.
Yield of juice, 651lbs.
Average daily fall in specific gravity at 28°C., ·0062.
Filtered 6th December, 1912. Specific gravity, 1·024.
Specific gravity in bottle, 1st May, 1913, 1·013.

REMARKS: Of similar character and quality to the preceding, but owing to the lower acidity somewhat softer in character.

Sam's Crab (Marden, Hereford).

Analysis of fresh juice, 22nd November, 1912:
- Specific gravity .. .. .. 1·044
- Malic Acid .. .. .. ·37%
- Tannin .. .. ·098%

Weight of fruit, 1,082lbs.
Yield of juice, 700lbs.
Average daily fall in specific gravity at 28°C., ·0058.
Filtered 3rd December, 1912. Specific gravity, 1·035.
Specific gravity in bottle, 1st May, 1913, 1·023.

REMARKS: Fairly sweet cider of slightly brisk character. Aroma and flavour fairly good.
Fair unblended, but somewhat lacking in character.

Skyrme's Kernel (Tewkesbury, Gloucester).

Analysis of fresh juice, 10th December, 1912:
- Specific gravity .. .. .. 1·043
- Malic Acid .. .. .. ·38%
- Tannin .. .. ·142%

Weight of fruit, 1,098lbs.
Yield of juice, 798lbs.
Average daily fall in specific gravity at 28°C., ·0042.
Filtered 6th January, 1913. Specific gravity, 1·030.
Specific gravity in bottle, 1st May, 1913, 1·021.

REMARKS: A medium sweet cider, fairly typical of the variety, although somewhat less in quality and briskness than usual.

Fairly satisfactory unblended, but improved by the addition of ciders of more body.

Yellow Styre (Tewkesbury, Gloucester).

Analysis of fresh juice, 15th November, 1912:
- Specific gravity .. .. .. 1·059
- Malic Acid .. .. .. ·80%
- Tannin .. .. ·102%

Weight of fruit, 1,190lbs.
Yield of juice, 846lbs.
Average daily fall in specific gravity at 28°C., ·0033.
Filtered 10th December, 1912. Specific gravity, 1·036.
Specific gravity in bottle, 1st May, 1913, 1·022.

REMARKS: A moderately sweet cider of decided briskness and good body. Flavour and aroma excellent.

Rather too sharp unblended, the acidity being higher for this kind than in most seasons. Valuable for blending.

Sweet Varieties. (Juice containing normally less than ·45 per cent. malic acid and ·2 per cent. tannin).

Devonshire Sweet (Bridgwater, Somerset).

Analysis of fresh juice, 3rd December, 1912:
- Specific gravity .. .. .. 1·050
- Malic Acid .. .. .. ·27%
- Tannin .. .. ·140%

Weight of fruit, 1,016lbs.
Yield of juice, 774lbs.
Average daily fall in specific gravity at 28°C., ·0064.
Filtered 24th December, 1912. Specific gravity, 1·024.
Specific gravity in bottle, 1st May, 1913, 1·017.

REMARKS: A medium sweet cider with characteristic flavour and aroma, somewhat lacking in quality.

Fairly useful for blending.

Eggleton Styre (Long Ashton, Somerset).

Analysis of fresh juice, 7th November, 1912:
- Specific gravity .. .. .. 1·044
- Malic Acid .. .. .. ·39%
- Tannin .. .. .. ·132%

Weight of fruit, 360lbs.
Yield of juice, 261lbs.

Average daily fall in specific gravity at 28°C., ·0062.
Filtered 19th November, 1912. Specific gravity, 1·034.
Specific gravity in bottle, 1st May, 1913, 1·020.

REMARKS: A medium sweet cider of very fair quality, briskness rather more marked than usual with this variety. Aroma and flavour pleasant.
Suitable for use alone or for blending.

French White (Tenbury, Worcester).

Analysis of fresh juice, 19th November, 1912:

Specific gravity	1·046
Malic Acid	·43%
Tannin	·132%

Weight of fruit, 980lbs.
Yield of juice, 688lbs.
Average daily fall in specific gravity at 28°C., ·010.
Filtered 4th December, 1912. Specific gravity, 1·018.
Specific gravity in bottle, 1st May, 1913, 1·003.

REMARKS: A coarse dry cider of poor quality. Aroma and flavour inferior.
Unsuited to use alone, and of little value for blending.

Morgan Sweet (Long Ashton, Somerset).

Analysis of fresh juice, 28th September, 1912:

Specific gravity	1·040
Malic Acid	·23%
Tannin	·078%

Weight of fruit, 1,512lbs.
Yield of juice, 1,193lbs.
Average daily fall in specific gravity at 28°C., ·011.
Filtered 20th January, 1913. Specific gravity, 1·000.
Specific gravity in bottle, 1st May, 1913, 1·000.

REMARKS: A thin, dry, coarse cider of unpleasant aroma and flavour. Inferior for blending.

Newton Sweet (Newton St. Cyres, Devon).

Analysis of fresh juice, 1st November, 1912:

Specific gravity	1·048
Malic Acid	·23%
Tannin	·194%

Weight of fruit, 1,230lbs.
Yield of juice, 909lbs.
Average daily fall in specific gravity at 28°C., ·006.
Filtered 18th November, 1912. Specific gravity, 1·028.
Specific gravity in bottle, 1st May, 1913, 1·019.

REMARKS: A moderately sweet cider, somewhat lacking in acidity, but very fair aroma and flavour. Somewhat lacks character, and therefore better adapted for blending than for use alone. A typical Devon variety.

Slack-ma-Girdle (Barton, Devon).

Analysis of fresh juice, 6th December, 1912:

Specific gravity	1·042
Malic Acid	·35%
Tannin	·126%

Weight of fruit, 1,120lbs.

Yield of juice, 798lbs.
Average daily fall in specific gravity at 28°C., ·0058.
Filtered 2nd January, 1913. Specific gravity, 1·019.
Specific gravity in bottle, 1st May, 1913, 1·011.

REMARKS: A very fair medium dry cider with pleasant aroma and flavour.

Satisfactory alone and very useful for blending.

Slack-ma-Girdle (Newton St. Cyres, Devon).

Analysis of fresh juice, 15th November, 1912:
Specific gravity .. .. .. 1·047
Malic Acid .. .. .. ·28%
Tannin .. .. ·114%
Weight of fruit, 971lbs.
Yield of juice, 673lbs.
Average daily fall in specific gravity at 28°C., ·0052.
Filtered 16th December, 1912. Specific gravity, 1·018.
Specific gravity in bottle, 1st May, 1913, 1·012.

REMARKS: A cider of very similar character to the preceding. One of the few varieties which turned sick.

Sweet Alford (Newton St. Cyres, Devon).

Analysis of fresh juice, 31st October, 1912:
Specific gravity .. .. .. 1·051
Malic Acid .. .. .. ·31%
Tannin .. .. ·164%
Weight of fruit, 1,589lbs.
Yield of juice, 1,109lbs.
Average daily fall in specific gravity at 28°C., ·0085.
Filtered 18th November, 1912. Specific gravity, 1·038.
Specific gravity in bottle, 1st May, 1913, 1·030.

REMARKS: A sweet cider of good quality, brisker than usual for this variety. Flavour and aroma very pleasant.

Good unblended.

Sweet Alford (Newton St. Cyres, Devon).

Analysis of fresh juice, 19th November, 1912:
Specific gravity .. .. .. 1·051
Malic Acid .. .. .. ·31%
Tannin .. .. ·164%
Weight of fruit, 1,128lbs.
Yield of juice, 827lbs.
Average daily fall in specific gravity at 28°C., ·0085.
Filtered 3rd December, 1912. Specific gravity, 1·042.
Specific gravity in bottle, 1st May, 1913, 1·028.

REMARKS: A sweet cider of good body and very fair aroma and flavour.

Owing to the unusually high acidity for this variety it was fairly well adapted for use alone, although the quality did not quite reach the normal for this sort. Made from the same lot of fruit as the preceding, but milled about three weeks later. The longer storage of fruit in this instance was evidently responsible for some loss of quality.

Woodbine (Newton St. Cyres, Devon).

Analysis of fresh juice, 26th November, 1912:
Specific gravity .. .. .. 1·050
Malic Acid .. .. .. ·38%
Tannin .. .. ·162%
Weight of fruit, 1,064lbs.
Yield of juice, 721lbs.
Average daily fall in specific gravity at 28°C., ·0087.
Filtered 19th December, 1912. Specific gravity, 1·016.
Specific gravity in bottle, 1st May, 1913, 1·003.

REMARKS: A dry cider with inferior flavour and aroma.
Indifferent for blending and unfit for use alone. This cider falls much below the usual standard for the variety.

Bittersweet Varieties. (Juice containing normally less than .45 per cent. malic acid and more than .2 per cent. tannin).

Ashton White (Long Ashton, Somerset).

Analysis of fresh juice, 2nd October, 1912:
Specific gravity .. .. .. 1·055
Malic Acid .. .. .. ·33%
Tannin .. .. ·324%
Weight of fruit, 584lbs.
Yield of juice, 418lbs.
Average daily fall in specific gravity at 28°C., ·0072.
Filtered 17th October, 1912. Specific gravity 1·032.
Specific gravity in bottle, 1st May, 1913, 1·010.

REMARKS: A bitter, dry cider of poor quality. Flavour and aroma inferior.
Moderate for blending. Very much below the standard of several former years.

Broadleaf Norman (Long Ashton, Somerset).

Analysis of fresh juice, 7th November, 1912:
Specific gravity .. .. .. 1·038
Malic Acid .. .. .. ·36%
Tannin .. .. ·158%
Weight of fruit, 490lbs.
Yield of juice, 375lbs.
Average daily fall in specific gravity at 28°C., ·0057.
Filtered 18th November, 1912. Specific gravity, 1·026.
Specific gravity in bottle, 1st May, 1913, 1·021.

REMARKS: A good medium sweet cider of pleasant aroma and flavour.
Fit for use unblended and well adapted for blending.

Brownthorn (Tenbury, Worcester).

Analysis of fresh juice, 22nd November, 1912:
Specific gravity .. .. .. 1·051
Malic Acid .. .. .. ·24%
Tannin .. .. ·198%
Weight of fruit, 1,507lbs.

Yield of juice, 982lbs.
Average daily fall in specific gravity at 28°C., ·0065.
Filtered 29th November, 1912. Specific gravity, 1·037.
Specific gravity in bottle, 1st May, 1913, 1·006.

REMARKS: A thin, dry cider, lacking in character and body. Flavour and aroma inferior.
Of little value for blending.

Chisel Jersey (East Lambrook, Somerset).

Analysis of fresh juice, 13th December, 1912:
Specific gravity .. .. .. 1·055
Malic Acid .. .. .. ·32%
Tannin .. .. ·465%
Weight of fruit, 1,065lbs.
Yield of juice,
Average daily fall in specific gravity at 28°C., ·0082.
Filtered 2nd January, 1913. Specific gravity, 1·032.
Specific gravity in bottle, 1st May, 1913, 1·023.

REMARKS: A medium cider of pronounced astringency. Flavour and aroma very fair.
Much too bitter unblended but useful for blending.

Coat Jersey (Martock, Somerset).

Analysis of fresh juice, 26th November, 1912:
Specific gravity .. .. .. 1·047
Malic Acid .. .. .. ·18%
Tannin .. .. ·266%
Weight of fruit, 1,097lbs.
Yield of juice, 809lbs.
Average daily fall in specific gravity at 28°C., ·010.
Filtered 9th December, 1912. Specific gravity, 1·030.
Specific gravity in bottle, 1st May, 1913, 1·020.

REMARKS: A medium sweet cider of some astringency. Aroma and flavour good.
Unsuited to use alone, but well adapted for blending.

Dabinett (Long Ashton, Somerset).

Analysis of fresh juice, 10th December, 1912:
Specific gravity .. .. .. 1·049
Malic Acid .. .. .. ·35%
Tannin .. .. ·238%
Average daily fall in specific gravity at 28°C., ·0045.
Filtered 31st December, 1912. Specific gravity, 1·022.
Specific gravity in bottle, 1st May, 1913, 1·013.

REMARKS: A medium dry cider, somewhat similar to the preceding, with rather more briskness.
Not unpleasant alone and useful for blending. Considering the small quantity of juice available the result for this sort was very good.

Early Red Jersey (Long Ashton, Somerset).

Analysis of fresh juice, 27th September, 1912:

Specific gravity	1·048
Malic Acid	·21%
Tannin	·174%

Weight of fruit, 635lbs.
Yield of juice, 450lbs.
Average daily fall in specific gravity at 28°C., ·0046.
Filtered 17th October, 1912. Specific gravity, 1·031.
Specific gravity in bottle, 1st May, 1913, 1·025.

REMARKS: A very good sweet cider of slight bitter-sweet character. Flavour and aroma pleasant, the astringency much less marked than usual with this variety.

Good for blending.

Newton Court (Newton Court, Monmouth).

Analysis of fresh juice, 13th November, 1912:

Specific gravity	1·050
Malic Acid	·42%
Tannin	·28%

Weight of fruit: 1,107lbs.
Yield of juice, 831lbs.
Average daily fall in specific gravity at 28°C., ·0077.
Filtered 9th December, 1912. Specific gravity, 1·013.
Specific gravity in bottle, 1st May, 1913, 1·003.

REMARKS: A thin, dry, bitter cider. Flavour and aroma unpleasant.

Inferior for blending and unfit for use alone.

Newton Red Jersey (Newton St. Cyres, Devon).

Analysis of fresh juice, 19th November, 1912:

Specific gravity	1·045
Malic Acid	·29%
Tannin	·186%

Weight of fruit, 1,260lbs.
Yield of juice, 939lbs.
Average daily fall in specific gravity at 28°C., ·0033.
Filtered 2nd December, 1912. Specific gravity, 1·037.
Specific gravity in bottle, 1st May, 1913, 1·022.

REMARKS: A very fair, medium sweet, cider, of typical bitter-sweet character. Flavour and aroma good.

Useful for blending.

Pocket Apple (Littlehempston, Devon).

Analysis of fresh juice, 5th November, 1912:

Specific gravity	1·047
Malic Acid	·27%
Tannin	·214%

Weight of fruit, 997lbs.
Yield of juice, 767lbs.
Average daily fall in specific gravity at 28°C., ·0062.
Filtered 18th November, 1912. Specific gravity, 1·030.
Specific gravity in bottle, 1st May, 1913, 1·021.

REMARKS: A medium sweet cider of slightly marked astringency. Flavour and aroma good.

Very useful for blending.

Pytheres (Newton Court, Monmouth).

Analysis of fresh juice, 13th November, 1912:
- Specific gravity .. .. .. 1·046
- Malic Acid .. .. .. ·32%
- Tannin .. .. ·154%

Weight of fruit, 1,108lbs.
Yield of juice, 829lbs.
Average daily fall in specific gravity at 28°C., ·0072.
Filtered 25th November, 1912. Specific gravity, 1·028.
Specific gravity in bottle, 1st May, 1913, 1·021.

REMARKS: A medium sweet cider of very slight astringency and pleasant flavour and aroma.

Good for blending and fit for use alone.

Red Norman (Tenbury, Worcester).

Analysis of fresh juice, 20th November, 1912:
- Specific gravity .. .. .. 1·055
- Malic Acid .. .. .. ·30%
- Tannin .. .. ·262%

Weight of fruit, 776lbs.
Yield of juice, 511lbs.
Average daily fall in specific gravity at 28°C., ·0037.
Filtered 20th December, 1912. Specific gravity, 1·034.
Specific gravity in bottle, 1st May, 1913, 1·029.

REMARKS: A sweet cider of fairly good quality. Astringency somewhat marked.

Useful for blending.

Royal Wilding (Marden, Hereford).

Analysis of fresh juice, 22nd November, 1912:
- Specific gravity .. .. .. 1·045
- Malic Acid .. .. .. ·17%
- Tannin .. .. ·17%

Weight of fruit, 1,219lbs.
Yield of juice, 942lbs.
Average daily fall in specific gravity at 28°C., ·0028.
Filtered 12th December, 1912. Specific gravity, 1·033.
Specific gravity in bottle, 1st May, 1913, 1·021.

REMARKS: A medium sweet cider of good quality, less astringent than usual for this variety. Flavour and aroma good.

Very useful for blending and pleasant alone despite of its lack of acidity.

Royal Wilding (Hardwicke, Gloucester).

Analysis of fresh juice, 1st November, 1912:
- Specific gravity .. .. .. 1·046
- Malic Acid .. .. .. ·18%
- Tannin .. .. ·224%

Weight of fruit, 1·046lbs.
Yield of juice, 650lbs.
Average daily fall in specific gravity at 28°C., ·0057.
Filtered 28th November, 1912. Specific gravity, 1·030.
Specific gravity in bottle, 1st May, 1913, 1·018.

REMARKS: A medium cider with some astringency. Aroma and flavour very fair.

Useful for blending, but somewhat lacking in body.

Royal Wilding (Tenbury, Worcester).

Analysis of fresh juice, 20th November, 1912:

Specific gravity	1·054
Malic Acid	·27%
Tannin	·240%

Weight of juice, 755lbs.
Yield of juice, 454lbs.
Average daily fall in specific gravity at 28°C., ·0065.
Filtered 16th December, 1912. Specific gravity, 1·023.
Specific gravity in bottle, 1st May, 1913, 1·013.

REMARKS: A medium dry cider, slightly astringent in character. Flavour and aroma very fair.
Useful for blending with sharp and sweet varieties.

Spreading Norman (Ledbury, Hereford).

Analysis of fresh juice, 28th November, 1912:

Specific gravity	1·048
Malic Acids	·36%
Tannin	·472%

Weight of fruit, 1,289lbs.
Yield of juice, 879lbs.
Average daily fall in specific gravity at 28°C., ·0082.
Filtered 3rd January, 1913. Specific gravity, 1·017.
Specific gravity in bottle 1st May, 1913, 1·012.

REMARKS: A dry, coarse cider. Aroma poor and flavour bitter and unpleasant.
Inferior for blending.

Strawberry Norman (Ledbury, Hereford).

Analysis of fresh juice, 9th January, 1913:

Specific gravity	1·043
Malic Acid	·19%
Tannin	·240%

Weight of fruit, 1,211lbs.
Yield of juice, 813lbs.
Average daily fall in specific gravity at 28°C., ·0057.
Filtered 17th January, 1913. Specific gravity, 1·035.
Specific gravity in bottle, 1st May, 1913, 1·010.

REMARKS: A dry, rather bitter cider of coarse quality and poor aroma and flavour. Moderate for blending.

Styre Wilding (Ledbury, Gloucester).

Analysis of fresh juice, 29th November, 1912:

Specific gravity	1·050
Malic Acid	·24%
Tannin	·21%

Weight of fruit, 1,140lbs.
Yield of juice, 700lbs.
Average daily fall in specific gravity at 28°C., ·0075.
Filtered 26th December, 1912. Specific gravity, 1·019.
Specific gravity in bottle, 1st May, 1913, 1·015.

REMARKS: A medium cider of very fair character. Flavour and aroma very fair.
Useful for blending.

White Norman (Tenbury, Worcester).

Analysis of fresh juice, 20th November, 1912:

Specific gravity	1·056
Malic Acid	·28%
Tannin	·238%

Weight of fruit, 183lbs.
Yield of juice, 118lbs.
Average daily fall in specific gravity at 28°C., ·0055.
Filtered 20th December, 1912. Specific gravity, 1·016.
Specific gravity in bottle, 1st May, 1913, 1·013.

REMARKS: A medium dry cider of pleasant bitter-sweet character. Useful for blending.

PERRIES.

Butt (Malvern, Worcester).

Analysis of fresh juice, 25th October, 1912:

Specific gravity	1·047
Malic Acid	·48%
Tannin	·104%

Weight of fruit, 1,256lbs.
Yield of juice, 921lbs.
Average daily fall in specific gravity at 28°C., ·005.
Filtered 13th November, 1912. Specific gravity, 1·036.
Specific gravity in bottle, 1st May, 1913, 1·023.

REMARKS: A medium sweet moderately brisk perry of fair flavour and aroma. Astringency appreciable, although less marked than usual with this variety.

Quality not good enough for use alone.

Huffcap (Tibberton, Gloucester).

Analysis of fresh juice, 5th December, 1912:

Specific gravity	1·053
Malic Acid	·34%
Tannin	·160%

Weight of fruit, 1,092lbs.
Yield of juice, 718lbs.
Average daily fall in specific gravity at 28°C., ·0062.
Filtered 31st December, 1912. Specific gravity, 1·032.
Specific gravity in bottle, 1st May, 1913, 1·026.

REMARKS: A sweet, fairly rich perry, of good flavour and aroma, but slightly lacking in briskness, thoroughly typical of the variety.

Moorcroft (Hardwicke, Gloucester).

Analysis of fresh juice, 23rd September, 1912:

Specific gravity	1·063
Malic Acid	·60%
Tannin	·07%

Weight of fruit, 1,976lbs.
Yield of juice, 1,525lbs.
Average daily fall in specific gravity at 28°C., ·0043.
Filtered 14th October, 1912. Specific gravity, 1·038.
Specific gravity in bottle, 1st May, 1913, 1·032.

REMARKS: A rich, sweet perry of some briskness. Flavour and aroma pleasant.

A good Moorcroft perry adapted for use unblended.

Newton Court (Newton Court, Monmouth).

Analysis of fresh juice, 12th November, 1912:

Specific gravity	1·045
Malic Acid	·40%
Tannin	·066%

Weight of fruit, 1,049lbs.
Yield of juice, 724lbs.
Average daily fall in specific gravity at 28°C., ·0095.
Filtered 2nd December, 1912. Specific gravity, 1·025.
Specific gravity in bottle, 1st May, 1913, 1·009.

REMARKS: A thin dry insipid perry of poor flavour and aroma, and lacking in character.
Inferior for blending.

Oldfield (Castlemorton, Worcester).

Analysis of fresh juice, 25th October, 1912:

Specific gravity	1·046
Malic Acid	·53%
Tannin	·076%

Weight of fruit, 2,301lbs.
Yield of juice, 1,551lbs.
Average daily fall in specific gravity at 28°C., ·0062.
Filtered 14th November, 1912. Specific gravity, 1·036.
Specific gravity in bottle, 1st May, 1913, 1·023.

REMARKS: A sweet medium brisk perry of good flavour and aroma, showing more of the Oldfield characteristics than the preceding.
Good alone.

Oldfield (Tewkesbury, Gloucester).

Analysis of fresh juice, 26th October, 1912:

Specific gravity	1·059
Malic Acid	·52%
Tannin	·178%

Weight of fruit, 1,235lbs.
Yield of juice, 919lbs.
Average daily fall in specific gravity at 28°C., ·0028.
Filtered 27th November, 1912. Specific gravity, 1·040.
Specific gravity in bottle, 1st May, 1913, 1·027.

REMARKS: A sweet rather rich perry of good body. Flavour and aroma somewhat marred by the presence of a peculiar taint, probably derived from the cask. Less typical of the Oldfield variety than the preceding.

Oldfield (Tibberton, Gloucester).

Analysis of fresh juice, 5th December, 1912:

Specific gravity	1·047
Malic Acid	·31%
Tannin	·058%

Weight of fruit, 1,076lbs.
Yield of juice, 754lbs.
Average daily fall in specific gravity at 28°C., ·0062.
Filtered 3rd January, 1913. Specific gravity, 1.022.
Specific gravity in bottle, 1st May, 1913, 1·018.

REMARKS: A medium sweet perry of good quality. Flavour and aroma pleasant.
Useful alone, although not possessing the usual Oldfield character.

Oldfield (Long Ashton, Somerset).

Analysis of fresh juice, 27th November, 1912:

Specific gravity	1·042
Malic Acid	·43%
Tannin	·068%

Average daily fall in specific gravity at 28°C., ·0155.
Filtered 18th December, 1912. Specific gravity, 1·030.
Specific gravity in bottle, 1st May, 1913, 1·014.

REMARKS: A thin, medium dry perry of moderate flavour and aroma. The quantity of fruit available being small, this perry was not up to the usual standard of this variety.

Pint (Tewkesbury, Gloucester).

Analysis of fresh juice, 26th October, 1912:

Specific gravity	1·047
Malic Acid	·71%
Tannin	·066%

Weight of fruit, 1,237lbs.
Yield of juice, 925lbs.
Average daily fall in specific gravity at 28°C., ·0077.
Filtered 11th November, 1912. Specific gravity, 1·031.
Specific gravity in bottle, 1st May, 1913, 1·020.

REMARKS: A medium sweet thin, brisk perry of inferior quality as regards flavour and aroma.
Requires to be blended.

Spice (Castlemorton, Worcester).

Analysis of fresh juice, 10th October, 1912:

Specific gravity	1·047
Malic Acid	·45%
Tannin	·170%

Weight of fruit, 1,970lbs.
Yield of juice, 1,500lbs.
Average daily fall in specific gravity at 28°C., ·0053.
Filtered 28th October, 1912. Specific gravity, 1·029.
Specific gravity in bottle, 1st May, 1913 1·023.

REMARKS: A sweet, medium brisk perry of very fair flavour and aroma: fairly useful unblended but improved by blending with a perry of more body.

Thorn (Castlemorton, Worcester).

Analysis of fresh juice, 4th October, 1912:

Specific gravity	1·042
Malic Acids	·52%
Tannin	·060%

Weight of fruit, 1,338lbs.
Yield of juice, 1,038lbs.
Average daily fall in specific gravity at 28°C., ·0043.
Filtered 28th October, 1912. Specific gravity, 1·029.
Specific gravity in bottle, 1st May, 1913, 1·018.

REMARKS: A moderately sweet, medium brisk perry of fair flavour and aroma.
Lacks character for use alone.

THE ACETIFICATION OF CIDER AND PERRY.

By B. T. P. Barker and Otto Grove.

The commonest disorder to which cider and perry are liable is undoubtedly acetification. In slight cases the effect upon the general character of the liquor is not very marked, and many consumers drink it without detecting anything wrong. In more severe cases the flavour of the cider or perry becomes very adversely affected, acquiring a vinegar-like character, which is not only decidedly unpleasant to the palate, but must also, in bad examples, have an injurious effect on the digestive organs. In extreme cases the liquor becomes undrinkable. On account of the extreme prevalence of this disorder—there are few six-months-old draught ciders made under ordinary circumstances which do not show some trace of it—and the difficulty of keeping it under entirely, the malady is a serious one for the maker, although with a little care there is no reason why any case should develop into a severe one.

All fermented liquids which contain relatively low amounts of alcohol—less, for example, than six to eight per cent.—are susceptible, the smaller the amount of alcohol the less being the power of resistance in general. Cider and perry, as drinks of weak alcoholic strength normally, are therefore particularly liable.

The disorder has long been known to be due to the action of a bacterium which possesses the power of acting on alcohol in the presence of air or oxygen,—oxygen being the essential factor—converting it into acetic acid, the characteristic constituent of vinegar. On cider left exposed for several days to air a growth in the nature of a semi-transparent film of varying thickness quickly appears. This consists of a mass of the bacteria in question and is commonly spoken of as the vinegar plant or "mother." In Devon such growths are frequently termed "mudes." The name of this type of acetic acid bacillus is *Bacterium xylinum*. A number of different kinds of bacteria capable of producing acetification have from time to time been met with in various fermented liquors such as wines and beers, the organism named being one. All kinds, however much they may differ in other respects, have in common the power of acetification.

Bacterium xylinum is the form generally associated with cider: but little attention hitherto seems to have been given to the subject as regards the kinds, if more than one, indigenous to cider. An investigation is therefore desirable, since the habits and, possibly also, the conditions of growth may vary somewhat in character. The subject has received attention at the Institute during the past year, ciders in various stages of the disorder having been collected from a number of distinct sources. The organisms from these ciders have been isolated, and tests made as to their acetic-acid-producing properties. At the present stage of the work it is evident that at least four different types of acetic bacteria are liable to occur in cider. The characters and conditions favouring or checking the growth of these organisms are now being studied in order to ascertain whether the same general form of treatment to check the disorder will apply equally well to all forms, or whether each kind requires separate consideration.

It has been stated above that cider and perry in cask generally shows more or less serious traces of acetification within six months or so after making. This is due to a number of distinct possible causes, of which the more important may here be briefly referred to. It has long been known that cider and perry fruit during storage prior to milling is exceedingly liable to acetify or "heat" under certain conditions. Storage in too deep or large a heap, wetness of the fruit, a high temperature, and the presence of bruised, broken, or decaying fruit in the heap, are all causes favouring acetification during storage. They give rise to conditions suitable to the free development of the acetic bacteria on the surface of the sound fruit or in the tissues of the bruised and broken fruit. Since the bacteria appear to occur invariably on the skin of the fruit in nature, the cider maker is obliged to start with infected material, and has, therefore, to devote his energies to the prevention of the multiplication of the pests rather than to the prevention of infection. After milling, the bacteria have abundant opportunity for activity, unless care is taken. Soaking or maceration of the pomace for several hours before pressing gives rise to trouble frequently, especially if the weather is inclined to be warm, on account of the somewhat considerable exposure to air which generally takes place. The practice of keeving the juice is at times risky for the same reason, unless measures are taken to bring it into a condition of fermentation rapidly. The solid matter which rises in the earliest stages of fermentation to form the brown head quickly becomes strongly acetic in character, if care is not taken to prevent access of air; and it should be removed by skimming, racking, or other means before it has time to cause much damage. During the stage of active alcoholic fermentation the chances of acetification are not serious on account of the carbon dioxide given off during fermentation

displacing the air, unless a large surface of the juice is exposed, or unless fermentation is on the slow side. When active fermentation approaches its end the danger increases considerably, unless air is kept away from the juice. After fermentation has ceased the risk is proportionately greater. Cider and perry are peculiarly difficult to deal with at this stage, not only on account of their low alcoholic strength, but also because of the completeness with which the alcoholic fermentation becomes played out in the majority of cases. The ciders of 1912–3 were particularly troublesome for this reason. So long as sufficient fermentation can be maintained to keep the cider charged with carbon dioxide, the liquor is to a great extent self-protected against acetification : and it is for this reason that the old practice of adding raisins, or other substances capable of encouraging the continuance of very slight fermentation after the final racking, was found advantageous in many cases. The modern custom of filtration has, however, greatly increased the risks of trouble at this stage on account of the liability of its leaving the liquor dead and incapable of after-fermentation in many instances. Finally, after the ciders have been put away in the store casks, and the latter filled to the bunghole and tightly bunged, great deterioration often occurs on account of the evaporation which seems to take place more or less regularly through the pores of the wood. An air space is thus formed above the liquor in the cask, and the presence of air results in acetification.

With so many opportunities for the development of the disorder it is not surprising, therefore, that it is so common. Experiments with the object of reducing the risk at each of the various stages just indicated have been in progress for several seasons with some measure of success ; and during the past season a number of methods in use on the Continent in the wine and cider industries have also been tried with results of more or less promise. Among the various systems tested may be mentioned (*a*) the washing of the fruit, prior to milling, with hot or cold water with the object of removing a large proportion of the bacteria, and in the former case also of injuring or killing them by heat ; (*b*) the addition of cultures of active yeast to the freshly pressed juice to induce fermentation with the least possible delay ; (*c*) the use of vent tubes permitting the escape of the gases formed during fermentation and preventing the access of air at all stages of fermentation ; (*d*) sterilisation, partial or complete, of the juice by heat, sulphuring, filtration and other methods, followed by fermentation with pure cultures of yeast ; (*e*) coating the casks with paraffin wax and other substances capable of rendering the wood of the casks impermeable to air and moisture, either by external or internal application ; (*f*) covering the surface of the liquor with a layer of a tasteless oil ; and (*g*) the use of bungs of special construction for the store casks. Instead of the usual

type, which range from two to three inches in depth, the bungs in question are about six to eight inches long, slightly tapering, and wrapped with waxed canvas. They are driven into the bunghole of the cask sufficiently far for the end in the cask to dip well into the cider. This keeps the wood of the bung constantly moist, so that shrinkage is prevented and the cask kept as air-tight as possible.

During the last two or three seasons many applications for advice with regard to the conditions of various bottled ciders have been received; and since the troubles have been mainly due to acetification, reference may be made to them conveniently here. Generally the chief cause of complaint was not so much the presence of an acetic taint in flavour as the occurrence in the liquid of fine floating filamentous material, commonly termed "fliers." These are simply growths of acetic bacteria, which in themselves would be practically invisible if it were not that, by the collection of minute fragments of the cell walls of the apple tissues remaining in the cider, yeast cells, and accidental solid particles of other nature, they are rendered objectionably conspicuous. The presence of these floating masses, if the cider at the time of bottling was in perfectly brilliant condition, indicates either (*a*) that air has obtained access to the contents owing to a defective cork or to the bottle being stored on its base and the cork thus permitted to dry, or (*b*) that the cider has been in too dead a condition as regards alcoholic fermentation to charge itself with carbon dioxide in time to restrict the growth of the bacteria. The former causes can easily be avoided with reasonable care; but the latter is by no means so simply dealt with, unless carbonation before bottling is regularly practised. What it means precisely is that, for the particular cider in question, the bottling has been performed too late in the season. It may appear from this that the remedy should be obvious and simple, viz., earlier bottling. In practice, however, there are difficulties in two directions. Firstly, while too late bottling causes the presence of "fliers," too early bottling results in the formation of too much yeast deposit and too much gas in bottle, owing to relatively excessive fermentation after bottling. It is easy, in attempting to avoid the evil in one direction, to overstep the mark and meet the other trouble. Secondly, it is at present difficult for makers to determine the correct time at which to bottle a given cider, unless they have a fairly complete history of the course of fermentation of the cider in question. Although March and April, the latter especially, are generally considered the best months for bottling, that view is correct only so far as the majority of ciders are concerned. Each cider has a proper period for bottling: but the periods of individual ciders do not necessarily coincide, and in some cases vary widely. Thus, for example, a cider which has fermented slowly can generally be bottled to best advantage in February or even earlier in many

instances : another which fermented at a moderate rate, in March or April : and yet another which underwent rapid fermentation, in May, June, or even later. Again, the cider made from certain fruit in some years may be best bottled at one period, and in other years at quite different times. Hence the problem of the time of bottling to avoid the formation of these acetic growths is decidedly intricate for those who rely upon the natural conditioning of their bottled ciders; and it calls for close attention to the course of fermentation of each individual cider, if any degree of certainty in the results is to be expected.

THE ESTIMATION OF TANNIN IN CIDER.

By C. W. Spiers.

The tannin of apples, although present in comparatively small proportion, is an important constituent of the juice. Its presence is considered by many to affect favourably the keeping qualities of the cider; and it may play a leading part in the clearing of the juice in the early stages after pressing.

It takes part also, in a manner not yet fully worked out, in the chemical changes accompanying the secondary fermentation usually known as the "sickness" of cider. The accurate determination of the tannin is therefore a matter of some importance; but before the present time no really satisfactory method has been worked out. Two methods of estimation actually used for cider may be referred to, the first being that of F. J. Lloyd [Report on Investigations on Cider Making (Board of Agriculture), pp. 5–6] and the second that recommended by Warcollier (Pomologie et Cidrerie, p. 486).

Lloyd titrates the juice directly with potassium permanganate according to the well-known method of Löwenthal, consequently including in the tannin content all the permanganate reducing substances present in the cider. Warcollier removes the tannin by means of catgut, which is allowed to remain in the liquid about six days; the method being thus too slow for constant use.

Botanists have devised methods for the estimation of tannin depending upon its precipitation by various reagents. Unfortunately, the fact that other substances present in plant juices are precipitated along with the tannin renders these methods valueless.

The method finally adopted was a modification of that of Körner and Nierenstein (Chem. Zeit. 36, 31, 1911), which consists in removing the tannin with casein and determining the total solids before and after detannizing. In this case the tannin removed was determined by the difference in the titration of the cider before and after detannizing. A solution of permanganate, of about 1 gm. per litre, is used, the titrations being carried out in a porcelain dish as in the method of Löwenthal. The casein used must be carefully freed from fat by long continued extraction with ether; and two quantities of 1 gm. each are shaken for 15 minutes with 50 cc. of the

cider. The tannin is thus completely removed, *but no other constituent of the cider.* Since the tannin of apples has not yet been isolated in the pure state, the results must be expressed, for the present, in terms of commercial "pure tannin." These commercial "pure tannins" are not homogenous substances ; and, therefore, the value obtained from the titration of a number of different samples, was compared eventually with that obtained from ammonium oxalate, a substance easily obtained in a pure state. A number of representative types of cider were analysed, and in all cases a lower, and more nearly correct tannin content was found than that obtained by direct titration alone as in Lloyd's method. A more detailed account of this method has been published in the "Journal of Agricultural Science," Vol. vi, Pt. 1, 1914.

The following table shows comparative results of the old direct titration permanganate method, and the new casein method :—

CIDER.	TANNIN BY DIRECT TITRATION.	TANNIN BY CASEIN METHOD.
Newton St. Cyres	0·38 per cent.	0·31 per cent.
Early Red Jersey	0·56 „ „	0·46 „ „
Dabinett	0·24 „ „	0.19 „ „
Frederick	0·14 „ „	0·10 „ „
Twistbody Jersey	0·67 „ „	0·50 „ „
Sam's Crab	0·16 „ „	0·12 „ „
Wallis' Red	0·19 „ „	0·18 „ „
Farmer's Friend	0·09 „ „	0·05 „ „
GlastonburyJersey	0·59 „ „	0·46 „ „
Neverblight	0·26 „ „	0·20 „ „
Ashton White	0·27 „ „	0.21 „ „
Sweet Alford	0·18 „ „	0·12 „ „

TRIAL CIDER AND PERRY ORCHARDS.

By B. T. P. Barker.

Since the establishment of the Institute in 1903 the propagation of the most promising vintage varieties examined in the course of the experimental work on cider-making has been carried on regularly in the nurseries at Long Ashton. The trees in due course have been distributed to County Councils contributing annual grants to the Institute in order that trial and demonstration vintage orchards should be established at suitable centres. The distribution of the trees began in 1908, and has been continued regularly according to the supply of trees available. During the winter of 1913 528 trees were distributed in this way, and in addition 108 trees were supplied to members and associates. Several of the former were utilised to fill gaps and replace unhealthy or dead trees in the trial orchards already established, the remainder being used for the establishment of new orchards. Fresh orchards were planted in Devon at Dainton and East Worlington; in Herefordshire; and in Worcestershire at Beauchamp Court. Several Sweet Alford trees were planted for trial purposes on farms in different districts of Gloucestershire, and in Monmouthshire some of the incomplete orchards were filled up. Details of the trees planted in the individual orchards are given in the table appended to this section.

The existing orchards in most cases appear to be progressing satisfactorily. As opportunity arises visits are being paid by members of the staff of the station. Analysis of the soils are being made Mr. Gimingham, and as the trees come into bearing the fruit is also being tested for vintage quality.

Reports as to the condition of individual orchards have been received this season as follows :—

Gloucester.—Mr. G. H. Hollingworth, Agricultural Organiser for the County, reports as follows :—

Orchards Planted in December, 1908.

Hardwicke.—This orchard continues to make good progress, and the experiment referred to in the last report showing the effect of turf over the roots of newly planted fruit trees has proved to be of great

educational value. The majority of the trees are doing well, but unfortunately several of them were injured in the stem through the boring caterpillar of the Wood Leopard Moth. The grassing experiment is being continued for the purpose of seeing the effect of the two methods a few years hence.

Berkeley.—Excellent growth was made last year by the majority of the trees in this orchard, which are now getting strong stems and fine heads. An experiment similar to that at Hardwicke is being carried on here, and though the advantage of cultivating round newly planted trees is clearly demonstrated, the difference is not so marked as at Hardwicke. I am afraid we shall lose one tree in this orchard through a bad attack of canker.

Lydney.—The growth of the trees here show that we were fortunate in our choice of situation, and good progress has been made during the past year. A few trees of several varieties are rather small but the majority have now got good stems and well balanced heads.

Orchards Planted in January and February, 1910.

Dymock.—In this orchard, devoted to perry pears, the trees have as a whole done remarkably well, the only exception being Barland, which in spite of its thick stems, is not promising in other respects as the bark on the younger wood is not clean and healthy and the shoots show a tendency to die back at the ends. The same thing is noticeable with this variety in the Berkeley orchard.

Tibberton.—This orchard is coming along in a very promising manner; the only disappointing variety being Cowarne Red, but we are endeavouring to replace the cankered trees with the above variety head-grafted on strong growing stocks. Good attention and careful cultivation round the trees are showing good effect in this orchard.

Various.—The Devonshire apple, Sweet Alford, has done remarkably well in the orchard where it was planted, and the habit of the tree as well as the character of the fruit are both commendable for orchard culture. With the object therefore of getting the variety more widely known a few trees supplied by the Institute have been planted in existing orchards at County Asylum Gloucester, Swindon near Cheltenham, Kempley, on the Worcestershire border of the County, Arlingham, the Severn Vale, and Compton Greenfield near Bristol. In addition to the establishment of new orchards it seems desirable that trees of certain vintage varieties that have been grown and tested at the Institute and proved to be really good, should be distributed in small quantities through the contributing counties for the purpose of establishing them in localities where they are unknown.

Hereford.—Mr. A. J. Manning, County Instructor in Horticulture, writes :—

In reply to your enquiry *re* the orchards planted with trees from the Institute, they continue to do very well indeed except that occasionally a fresh spot of canker makes an appearance. The West of England varieties are doing extremely well, making very free well matured growth, and this season blooming very freely. I think there will be quite a good crop of all kinds this season. If so, I shall, if possible, send you a lot to get the juice tested. Cowarne Red, which has been so much trouble to us hitherto, is now, I believe, coming good at last.

Monmouth.—Mr. W. J. Grant, Director of Agricultural Education, reports as follows :—

Although the continued dry weather has not had a beneficial effect on the young orchards, their condition on the whole is satisfactory. The orchards have derived benefit from the continuance of sunshine during the past summer, having made and matured excellent growth compared with that of last year. The good effects of basic slag and superphosphate on the young trees treated at Tyllwyd, Llansoy, is indicated by the sturdy growth and fine foliage.

Devon.—The following report has been submitted by Mr. C. Berry, Horticultural Instructor for the County :—

Killerton Orchard, near Exeter.—Foxwhelp (Black) trees are early in growth of fruit buds, and the trees are healthy. There is a fair amount of fruit buds. Improved Pound.—Growth late and irregular. Very clean and strong-growing trees. Two feet prunings. Pruned to nine inches up from base. A few trees crowded with Mussel Scale where trees were tied to stakes. One tree is nearly covered with scale from the soil to the top of stem. One tree is cankered where the tie was. Deux Amer.—Short-pruned during the first three years some of these trees. Some of the long-pruned branches have dormant buds at the bottom. The trees are doing well. The short-pruned trees are full of fruit-buds. Yarlington Mill.—The middle or fair pruning appears to suit this variety, but the unpruned is the best tree in Killerton orchard. As to the different ways of pruning it is too early to form a correct opinion.

The other orchards differ little from Killerton except that Killerton is, and will be, cultivated soil. Okehampton orchard also is partly cultivated. The cultivated soils in both places have the best trees by far. Little fruit so far has been gathered. In two more years I shall be able to report something more definite. At Okehampton Cherry Norman is cankering badly. Red Streak is doing well. Cowarne Red thrives. Knotted Kernel is planted on

cultivated soil. At King's Nympton some of the trees have got loose and the bark is damaged a little. The stakes used were quite green (not seasoned wood) and the tops of the stakes warped and met, in some cases jamming the bark. Branscombe orchard trees are not growing very quickly. A few trees are injured by the wire being broken by cattle breaking into the orchard. The soil is chalky and thin. The trees have improved during 1913.

At Mr. Wm. Maddicott's farm, Brookhill Field, Dainton, Ipplepen, near Newton Abbot, 144 trees were planted, 31 feet apart, in January, 1914. Cost of planting was as follows :—

	£	s.	d.
Cutting Stakes, 2 days at 3s.	0	6	0
Carriage of Trees from Station	0	5	0
Carriage of Trees from Long Ashton... ...	1	1	7
Digging holes 6 feet across, 2 feet 6 inches deep and planting trees at 3s. a day—58 days ...	8	14	0
Man and two horses drawing dung and wayside soil, 3 days	1	10	0
Wire fencing for trees	1	0	0
2¼ cwt. Dissolved Bone	0	8	3
18 Cartloads of Dung at 3s. 6d.	3	3	0
	£16	7	10

The soil is limestone, and a few holes showed the stone near the surface, but nearly all the holes had soil 15 inches deep.

East Worlington orchard was planted this season in a similar manner, but with less farmyard manure. The soil was deeper and somewhat richer.

Somerset.—Mr. John Ettle, County Instructor in Horticulture, has furnished the following report :—

At each of the orchards we have had to plant several trees to replace those which have not done well or have died from various causes. The varieties selected for trials are those which have been taken from Hereford, Worcester, Gloucester, Devon, Somerset and Normandy, and several of those lost have not been congenial to the soil, district, or climate. Losses of this kind are bound to occur in any kind of experimental work.

The experiments prove that some "Herefords" will not do well in Somerset. From reports received at the Institute we find that some "Somersets" will not do well in Hereford. For example, the Kingston Black is not a profitable variety in several counties as it is a bad grower (and it is not a good grower in Somerset). Cowarne Red, a Hereford and Gloucester variety, does badly in Somerset, as it is impossible to stop it from cankering.

To account for the losses by soil difficulties is scarcely possible, as Mr. Harry Gibbons, at Clutton, with one of the worst orchard soils to contend with, has only had to replace two Kingston Black. Mr. Masters, at Barton St. David, has had to replant six, and I hope next year he will be able to fill out his orchard with about sixty more. This will be on new ground. Messrs. Tilley lost nearly all their trees through some foolish person cutting with a hook the heads or stems of the trees. Mr. House, at Christon, accounts for his losses through the very dry season just after the trees were planted. As far as possible this year varieties lost have been replaced, but a number of strong growing varieties have been planted to be re-grafted. For example, Eggleton Styre, a good grower from Hereford, will be head-grafted with Cowarne Red, a poor Hereford grower. Very much the same thing has happened in this county as in others, which can be seen from the report issued from the Institute.

As regards the treatment locally of the trees, at Clutton, Mr. Harry Gibbons' boys have done most of the pruning under my supervision, and the boys from the Council School were given lessons as well. At Barton St. David, Mr. Masters and his son have done the pruning. Mr. Tilley, jun., has been responsible at Shepton, and Mr. House at Christon.

One very pleasing thing in connection with these orchards is to see how well perry pears are growing. They are out-growing the apples in every case. We expected this before we planted them, and it is surprising that Somerset farmers did not plant perry pears generations ago to mix with the cider apples.

Worcester.—The following reports have been collected by Mr. A. Weston Priestley, Director of Education :—

Newnham Court, Tenbury.—Mr. E. Vincent V. Wheeler reports : The trees I had from the National Fruit and Cider Institute are all alive and making fair growth. The only trees that have borne any quantity of fruit are the Medaille d'Or, which were heavily loaded for their size last year. There were one or two apples on the Broad-leaf Norman, but no quantity. Mr. Barker visited the orchard on March 12th.

Madresfield Court Gardens, Malvern.—Mr. W. Crump writes as follows :—I beg to state that the 50 cider and perry trees received from the National Fruit and Cider Institute have done splendidly and are now in perfect condition. We should like your expert to see them for comparison with those received by other growers.

Beauchamp Court, Worcester.—Mr. William H. Gabb writes :—I am pleased to say the perry pear trees that I had two years ago have done very well indeed and are making good progress. The trees

NEW EXPERIMENTAL ORCHARDS PLANTED IN 1913–4.

Centre.	Varieties Selected.			
	Apples.			Pears.
	Sharp.	Sweet.	Bittersweet.	
Devon County Trees.				
Dainton, Ipplepen ..	Cap of Liberty (12) Cherry Pearmain (5) Skyrme's Kernel (10) Oakham Green (15) Kingston Black (5)	Sweet Coppin (5) Eggleton Styre (10) Stubbard (5) Sweet Alford (10) Doux Amer (5)	Knotted Kernel (20) Royal Jersey (5) Strawberry Norman (18) Médaille d'Or (14) White Close Pippin (5)	
East Worlington ..	Cap of Liberty (12)	Sweet Coppin (12)	Knotted Kernel (24) Strawberry Norman (12) Médaille d'Or (12)	
Hereford County Trees.	Cap of Liberty (10)	Sweet Coppin (10) Eggleton Styre (12) Sweet Alford (12) Smyth-Osbourne No.7 (10)	Knotted Kernel (12) Strawberry Norman (12) Médaille d'Or (12) Rouge Bruyère (10)	
Worcester County Trees.				
Beauchamp Court, Worcester ..	Cap of Liberty (10)	Sweet Alford (15) Eggleton Styre (10)	Cherry Norman (15)	Barland (25) Oldfield (5) Taynton Squash (10) Moorcroft (10)

The numbers in brackets indicate the number of trees of the variety in question.

which I have had this season were a very good lot and came to hand very well packed. They were planted without delay and should do very well.

Woollas Hill, Pershore.—Mr. J. William Dee reports as follows :—The apple and pear trees I had from the National Fruit and Cider Institute have done very well and are getting fair sized trees and will bear in a year or two. The pears have had some fruit on the last two years.

Staunton Court, Gloucester.—Mr. J. G. Hawkins sends the following report :—I have kept the turf pared around these trees and with the exception of the few which died in the last drought all are looking well. The greatest thing, I think, is to cultivate the sorts least liable to American blight.

The Stocks, Suckley.—Mr. J. H. W. Best states :—The trees I had from Bristol are doing well.

Upton-on-Severn.—Mr. William S. Lane writes as follows :—There is little further this year to report. Two trees are dead—they were planted at one corner of the orchard, where there is very little soil, on hard marl. I do not advocate replanting on this spot ; and as the 50 trees practically filled up the enclosure, I think it better to be content with the remaining 48 trees which I am glad to say are making good growth and appear very healthy.

Manor Farm, Moor, Pershore.—Mr. T. W. Oldham reports :—*Re* cider trees planted at Moor, I regret to say the apples are practically all dead, but the pears took their growth well.

Powick, near Worcester.—Mr. G. Braine Hartnell writes :—The cider trees are in good condition, and the majority have been slightly pruned.

Frampton Cotterell, Gloucester.—Mr. J. P. Eley writes :—I beg to report that the trial orchard which was planted with trees supplied by the National Fruit and Cider Institute is going on very satisfactorily. Although the summer months of 1913 were somewhat dry, a strong growth has been made during the last twelve months. The trees have again been recently cut back and pruned, and the ground at the base of the tree forked over and a little farmyard manure put. I am looking for continued progress during the coming year.

Chew Stoke, Somerset.—Mr. Eldred G. F. Walker sends the following report :—The experimental perry pear orchard that I planted is now fairly complete. It has already proved that pears will thrive where apple trees will not. It is rather singular that practically every apple tree, as well as two varieties of the pears, Port and Claret, has died out. I have replaced them several times

unsuccessfully; take what precautions I will they die, sometimes the first, but generally the second season. As to the other varieties the non-headed-back trees are making best growth, and most of these have fruited heavily, particularly Taynton, Moorcroft, Blakeney, Oldfield and Barland. Neither Huffcap, Holmer, Butt and Pine pears have fruited; the Lintoff is a very weak grower, hardly suitable for orchard work. The trees have evidently benefitted from the heavy dressing, one ton per acre, of basic slag that I applied two years ago.

Aspall Hall, Suffolk.—Mr. J. B. Chevallier's report is as follows:—The standard trees of vintage fruit are all making satisfactory growth, and commensurate with their size an ample crop was produced by Eggleton Styre and Cremière, while a fair crop was given by White Jersey, Argile Grise, Neverblight and Sweet Coppin. The following still remain barren:—Moorcroft, Victoria, Knotted Kernel, Chevallier, Strawberry Norman, Hardwick.

Between the rows of Barland and Eggleton Styre bush trees of Lane's Prince Albert are planted: and these last, in spite of spraying like the others with Herrod's wash, were particularly infested with aphis. This attack has been followed by a peculiar kind of canker, which spreads over portions of the bark of arms and shoots. These have been sprayed with sodalin. Specimens were sent to the Institute for examination. The rest of the orchard seems healthy.

Harper-Adams Agricultural College, Newport, Salop.—Mr. G. T. Malthouse has supplied the following report:—The cider and perry trees have made excellent growth during the past year and all varieties give promise of a good crop this year. The trees are healthy and free from fungoid or insect pests. They have been sprayed three times as follows:—January, 1913, Winter Wash; June, 1913, Arsenical Wash; September, 1913, Copper-Paraffin Wash. It was anticipated that there would be a good crop of cider fruit, but most of the fruit fell off early in the season, as was the case with other apples. The roots have spread well and an examination shows that all trees have rooted freely near the surface. In future severe pruning will be discontinued and thinning will be practised instead as the heads are now well balanced.

Chippenham, Wilts.—Mr. Lionel H. Marshall reports:—I much regret to have to report that the cider apple trees which were supplied by the Institute to the late Mr. Phipps, and planted by his tenant at Bremeridge Farm, were a total failure. Some of the trees did well for a time but the protection round them was not attended to and the bark was stripped from them by sheep.

Woolston, North Cadbury, Somerset.—Messrs. C. Osborn and

Son write as follows :—We are pleased to say that the apple and pear trees are making excellent progress. They have not borne yet, as we have cut back the heads several times to encourage the growth of nice trees, with firm stems, by the time the fencing decays.

Butleigh, Somerset.—Mr. R. Neville-Grenville sends the following report :—The stronger growing varieties of Apple trees from the Institute have only made fairly good growth during the past season. The less vigorous sorts have made no perceptible growth of head or increase of stem girth, but are all well furnished with fruit buds. None of them compare well with home grown trees of the same age, and under the same conditions, which are grafted on stocks of Morgan Sweet or Court Royal, the latter being the best of the two.

THE COMPOSITION OF VINTAGE APPLE AND PEAR JUICES, 1913-14.

By Otto Grove.

The accompanying tables, A and B, contain the results of the analyses of the fresh juices of vintage apples and pears examined during the 1913–14 fruit season. Table A includes varieties which have been purchased for experimental purposes in the cider house in addition to those sent in for examination by growers. A few sorts grown at the Institute are also included, where the bulk was sufficient for cider-making on a practical scale.

Table B deals exclusively with juices obtained from fruit grown in the orchards and plantations at the Institute. As in previous years, samples of fruit from each tree bearing a crop during the season in question have been kept distinct and examined separately, the juices of any individual variety being pressed and analysed as far as possible on the same day in order that the results from each tree of the same sort should be strictly comparable. Care was taken that each sample should be fairly representative of the bulk of fruit produced by the tree.

With regard to the results as a whole there are a few points of special interest to which attention may be drawn. Perhaps the most striking feature is the irregularity of the specific gravity figures. In view of the unusually fine and dry summer of 1913 gravities well above the average might well have been expected. While this has been the case with some of the juices, in many instances—perhaps indeed in the majority—the figures are, if anything, below rather than above the average. It is surprising for instance to find Morgan Sweet showing a gravity of 1·056, this figure being well above the average for the variety, while from the same orchard at Long Ashton Ashton White, a variety ripening about the same period as the former, has a gravity of 1·048, which is on the low side for this sort. Again, two samples of Kingston Black apples in bulk, grown in the Tewkesbury district, possess gravities of 1·069 and 1·053 respectively, a remarkable difference considering that the results were obtained from the juice of half-ton weights of fruit in each case.

The acidities generally were inclined to be slightly below the

average, and the tannins showed the same tendency rather more markedly. The rates of fermentation were very slow in many cases and were almost throughout less than the normal for the respective varieties, a complete contrast in this respect from the 1912–3 juices.

In Table B it will be noticed that adjoining trees of the same variety very frequently show comparatively large differences, indicating that the tree itself plays a part of its own in the determination of the composition of the fruit, independent altogether of the effect of external conditions on the tree. The latter cannot differ widely in the case of adjoining trees. Reference to the averages for the Dabinett trees, given in Table C in another section of this Report,* will show that although the variations between individual trees of the same variety may be comparatively large in any one year, the tendency nevertheless is for the average compositions taken over a series of years to approach one another very closely. This again indicates that the tree itself plays a part independent of external conditions.

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* *Vide* Stock Influence upon the Vintage Quality and other Characters of Apples.

TABLE A.—ANALYSES OF APPLES AND PEARS, 1913–1914.

Name of Variety.	Specific Gravity of Juice.	Percentage Composition of Juice.			Rate of Fermentation.	Grower	District.
		Total Sugar. Approximate.	Malic Acid.	Tannin.			
APPLES.							
ASHTON WHITE	1·048	9·5 —11·5	·17	·33	6·5	Cider Institute ..	Long Ashton S.
BICKINGTON GREY	1·050	10—12	1·01	·20	3·	I. W. F. Bickford ..	Newton Abbot D.
BRAMTOT	1·060	12·5 —14·5	·38	·19	9·	F. W. Crawshay ..	Hempnall, Norfolk
BRICE'S KERNEL	1·045	8·75—10·75	·64	·15	4·3	Rev. Dowdeswell ..	Pull Court, Tewkesbury G.
BROADLEAF FRENCH ..	1·053	10·75—12·75	·22	·31	7·2	E. W. Caddick ..	Caradoc, Ross H.
BROADLEAF NORMAN ..	1·063	13·25—15·25	·30	·25	5·1	F. W. Crawshay ..	Hempnall, Norfolk
CADBURY, No. 1	1·052	10·5 —12·5	·24	·32	4·5	C. Osborn	North Cadbury S.
CAP OF LIBERTY	1·050	10—12	·78	·25	2·6	J. H. Symes ..	Martock S.
Ditto	1·064	13·50—15·50	·61	·19	8·5	Cider Institute ..	Long Ashton S.
CHISEL JERSEY	1·074	16—18	·20	·57	7·8	F. W. Crawshay ..	Hempnall, Norfolk
CHERRY NORMAN	1·045	8·75—10·75	·16	·26	7·	E. G. Shew ..	Cold Green, Bosbury G.
COLEBROOK	1·059	12·25—14·25	·19	·22	5·8	J. H. E. Willis ..	Martock S.
COWARNE RED	1·050	10—12	·41	·21	3·6	T. Marston ..	Boddington, Cheltenham G.
DITTO	1·051	10·25—12·25	·54	·21	8·4	Cider Institute ..	Long Ashton S.
CRIMSON QUEENING	1·052	10·50—12·50	·17	·18	6·1	R. T. Hinckes ..	Foxley H.
DABINETT..	1·058	12—14	·11	·27	7·6	Cider Institute ..	Long Ashton S.
DUKE OF BEDFORD	1·042	8—10	·22	·20	5·8	F. R. Willcox ..	Oldbury-on-Severn G.
DYMOCK RED	1·054	11—13	·50	·23	4·1	C. Smith	Vineyards, Ledbury G.
EGGLETON STYRE	1·067	14·25—16·25	·30	·10	8·	Wm. J. Masters ..	Barton St. David S.
FARMER'S FRIEND	1·049	9·75—11·75	·17	·20	5·3	C. Porter	South Petherton S.
FERTILE DE CAEN	1·050	10—12	·15	·18	12·2	Cider Institute ..	Long Ashton S.
GATCOMBE	1·052	10·50—12·50	·36	·14	4·9	W. Butler	Long Ashton S.
HILL'S APPLE	1·058	12—14	·67	·40	3·3	Winter	Bristol G.
HORNER	1·054	11—13	·16	·26	5·2	J. H. Symes ..	Martock S.
JERSEY No 2	1·052	10·50—12·50	·15	·28	3·8	C. Osborn	North Cadbury S.

Name of Variety.	Specific Gravity of Juice.	Percentage Composition of Juice.			Rate of Fermentation.	Grower.	District.
		Total Sugar. Approximate.	Malic Acid.	Tannin.			
APPLES—*continued*							
JERSEY No. 4	1·050	10—12	·19	·22	5·	C. Osborn	North Cadbury S.
KINGSTON BLACK	1·069	14·75—16·75	·67	·14	4·6	T. Jeffs	Pendock, Tewkesbury G.
DITTO	1·053	10·75—12·75	·48	·20	5·5	Rev. Dowdeswell ..	Pull Court, Tewkesbury G.
DITTO	1·059	12·25—14·25	·57	·10	5·1	F. R. Willcox ..	Oldbury-on-Severn G.
DITTO	1·069	14·75—16·75	·59	·25	2·8	Ash Orchard ..	Martock S.
KNOTTED KERNEL	1·063	13·25—15·25	·18	·35	5·3	F. W. Crawshay ..	Hempnall, Norfolk
DITTO	1·071	15·25—17·25	·33	·37	5·	Ditto	Ditto
LARGE WHITE	1·050	10—12	·23	·18	4·1	Ash Orchard ..	Martock S.
LITTLE WILDING	1·053	10·75—12·75	·16	·23	6·8	G. Smith	Vineyards, Ledbury G
MASTER'S JERSEY	1·058	12—14	·18	·30	4·3	C. Osborn	North Cadbury S.
MIDDLE STREAK	1·051	10·25—12·25	·17	·30	6·1	Ditto ..	Ditto
MORGAN SWEET	1·056	11·50—13·50	·22	·17	9·2	Cider Institute ..	Long Ashton S.
O.K.	1·058	12—14	·70	·09	6·9	F. W. Crawshay ..	Hempnall, Norfolk
POCKET APPLE	1·052	10·50—12·50	·33	·20	4·1	I. W. F. Bickford ..	Newton Abbot D.
POPLE	1·043	8·25—10·25	·73	·25	7·2	F. R. Willcox ..	Oldbury-on-Severn G.
PULL COURT RED	1·050	10—12	·53	·20	7·7	Rev. Dowdeswell ..	Pull Court, Tewkesbury G.
QUEEN ANNE	1·048	9·50—11·50	·13	·05	4·3	J. H. E. Willis ..	Martock S.
RED FRENCH	1·050	10—12	·24	·19	9·5	E. W. Caddick ..	Caradoc, Ross H.
RED SOLDIER	1·053	10·75—12·75	·73	·18	3·9	C. Smith	Ledbury G.
RED STREAK	1·060	12·50—14·50	·60	·14	7·	F. W. Crawshay ..	Hempnall, Norfolk
ROYAL JERSEY No. 1 ..	1·053	10·75—12·75	·21	·38	4·4	J. H. Symes ..	Martock S.
DITTO No. 2	1·051	10·25—12·25	·21	·28	5·1	Ditto	Ditto
SANDFORD JERSEY	1·075	16·25—18·25	·19	·62	5·	F. W. Crawshay ..	Hempnall, Norfolk
SEEDLING	1·048	9·50—11·50	·79	·24	5·1	R. Harding ..	Long Ashton S.
SEEDLING	1·053	10·75—12·75	·10	·10	5·2		

SEEDLING	1·054	11– 13	·85	·23	1·8	Cider Institute ..	Long Ashton S.
SEEDLING	1·055	11·25– 13·25	·17	·22	5·5	W. Rossiter ..	Martock S.
SKYRME'S KERNEL	1·054	11—13	·57	·22	2·6	T. Marston ..	Boddington, Cheltenham
SOPS OF WINE	1·065	13·75—15·75	·19	·13	6·	F. W. Crawshay ..	Hempnall, Norfolk
SLACK MA GIRDLE	1·049	9·75—11·75	·21	·13	5·	J. W. F. Bickford	Newton Abbot D.
SWEET ALFORD	1·049	9·75—11·75	·15	·20	2·6	Ditto	Ditto
SWEET COPPIN	1·064	13·50—15·50	·29	·10	9·	Wm. J. Masters ..	Barton St. David S.
STRAWBERRY NORMAN ..	1·052	10·50– 12·50	·35	·32	6·1	C. Smith	Ledbury G.
TAYLOR'S BITTER	1·050	10 –12	·20	·18	5·8	C. Porter	South Petherton S.
TRUCKLE	1·059	12·25– 14·25	·32	·18	4·2	Ash Orchard ..	Martock S.
TWISTBODY JERSEY	1·061	12·75—14·75	·20	·45	5·3		Kingsbury S.
WHITE NORMAN	1·054	11—13	·21	·23	3·4	E. G. Shew ..	Bosbury G.
YELLOW STYRE	1·058	12—14	·62	·06	3·6	Rev. Dowdeswell ..	Pull Court, Tewkesbury G.
YEOVIL SOUR	1·048	9·50—11·50	·38	·19	3·2	Ash Orchard ..	Martock S.
PEARS.							
COPPICE	1·051	10·25—12·25	·38	·08	5·3	T. C. Watson ..	Malvern

TABLE B.

COMPOSITION OF JUICES FROM YOUNG ORCHARD TREES & PARADISE STOCK TREES.

Name of Variety.	Number of Tree.	Composition of Juice, 1913. Specific Gravity.	Malic Acid, per cent.	Tannin, per cent.	Daily Fall in Specific Gravity at 27 deg. C.
Bedan des Partes (head-grafted on Broadleaf Jersey 1906)	1	1·049	·14	·30	7·7
Ditto (ditto)	2	1·057	·23	·30	8·6
Ditto (on Paradise stock) ..	169	1·050	·12	·33	6·2
Black Norman	2	1·056	·35	·23	11·2
Bramley's Seedling (on Paradise stock)	459	1·041	·65	·13	13·
Bramtôt (on Paradise stock)	118	1·043	·57	·12	8·6
Ditto (ditto)	120	1·048	·68	·16	4·7
Ditto (ditto)	121	1·044	·81	·14	7·8
Ditto (ditto)	122	1·042	·75	·13	7·8
Broadleaf Jersey	1	1·060	·32	·42	9·8
Ditto	2	1·060	·30	·34	11·6
Ditto	3	1·060	·30	·36	10·2
Ditto	4	1·065	·32	·39	12·
Broadleaf Norman	1	1·048	·17	·24	3·6
Ditto	2	1·048	·18	·24	8·8
Ditto	4	1·045	·22	·43	4·3
Ditto	5	1·045	·12	·21	3·
Ditto	6	1·048	·21	·22	3·3
Ditto	8	1·055	·16	·25	6·
Ditto	9	1·050	·13	·26	5·5
Ditto (on Paradise stock)	64	1·056	·10	·23	6·
Ditto (ditto)	65	1·039	·11	·19	3·7
Ditto (ditto)	67	1·050	·10	·17	7·
Cap of Liberty (head-grafted on Morgan Sweet, 1905)	2	1·045	·56	·21	10·7
Ditto (ditto, 1906)	3	1·060	·76	·26	11·2
Ditto (ditto)	4	1·055	·72	·19	9·2
Ditto (ditto)	5	1·066	·71	·24	10·5
Ditto (ditto)	8	1·065	·58	·15	9·3
Ditto (ditto)	9	1·055	·63	·16	8·3
Ditto (head-grafted on Broadleaf Jersey)	180	1·057	·66	·21	7·8
Ditto (on Paradise stock)	251	1·048	·66	·23	11·
Ditto (ditto)	252	1·046	·59	·28	10·5
Ditto (ditto)	253	1·043	·67	·27	10·2
Cherry Norman	1	1·048	·17	·32	3·4
Ditto	2	1·046	·10	·27	3·5
Ditto	4	1·056	·14	·39	3·4
Ditto	5	1·045	·14	·30	2·6
Ditto	6	1·046	·13	·26	2·3
Ditto	7	1·048	·13	·30	2·6
Ditto	8	1·042	·14	·23	2·6
Ditto	10	1·045	·14	·24	2·
Cherry Pearmain (on Paradise stock) ..	211	1·049	·22	·17	14·5
Ditto (ditto)	213	1·048	·34	·14	15·
Ditto (ditto)	214	1·041	·32	·15	20·5
Chevalier (on Paradise stock)	131	1·040	·11	·20	12·
Ditto (ditto)	132	1·052	·12	·22	10·5
Ditto (ditto)	133	1·048	·11	·22	8·5
Ditto (ditto)	134	1·051	·09	·19	12·2

TABLE B—*continued.*

Name of Variety.	Number of Tree.	Composition of Juice, 1913.			
		Specific Gravity.	Malic Acid, per cent.	Tannin, per cent.	Daily Fall in Specific Gravity at 27 deg. C.
Chiffers (on Paradise stock)	485	1·046	·22	·18	15·3
Ditto (ditto)	490	1·049	·23	·18	9·8
Chisel Jersey	2	1·050	·21	·33	5·
Ditto	3	1·053	·18	·34	5·9
Court Royal	4	1·051	·15	·14	10·5
Ditto	5	1·055	·26	·15	8·8
Cowarne Red	1	1·052	·55	·27	8·4
Ditto	2	1·050	·54	·26	7·8
Ditto	3	1·051	·40	·27	8·4
Ditto	7	1·052	·58	·28	8·8
Ditto	8	1·054	·62	·28	9·2
Ditto	9	1·051	·57	·19	7·8
Ditto	10	1·045	·52	·22	8·2
Ditto (on Paradise stock) ..	60	1·052	·28	·21	8·4
Ditto (ditto)	272	1·043	·28	·14	14·5
Ditto (ditto)	273	1·046	·42	·18	14·
Ditto (ditto)	274	1·038	·41	·18	14·
Cremière (head-grafted on Warner's King, 1905)	68	1·048	·25	·12	9·
Ditto (on Paradise stock) ..	429	1·051	·17	·22	9·8
Ditto (ditto)	430	1·049	·16	·16	9·
Ditto (ditto)	431	1·050	·14	·17	10·
Ditto (ditto)	433	1·049	·13	·15	9·8
Ditto (ditto)	435	1·048	·14	·13	8·6
Doux Amer (head-grafted on Broadleaf Jersey, 1905)	77	1·051	·16	·13	8·8
Ditto (on Paradise stock)	359	1·045	·11	·13	11·3
Ditto (ditto)	360	1·045	·11	·15	10·
Ditto (ditto)	361	1·044	·13	·17	10·5
Ditto (ditto)	362	1·045	·13	·15	11·2
Ditto (ditto)	363	1·047	·14	·17	11·7
Dove (on Paradise stock)	366	1·048	·09	·15	4·9
Ditto (ditto)	367	1·052	·09	·16	17·
Ditto (ditto)	368	1·053	·13	·14	12·5
Ditto (ditto)	370	1·053	·15	·15	13·2
Ditto (ditto)	371	1·052	·21	·13	13·
Ditto (ditto)	372	1·046	·22	·09	18·
Dymock Red	1	1·056	·33	·14	10·7
Ditto	2	1·059	·35	·13	14·7
Ditto	3	1·042	·30	·15	6·6
Ditto	4	1·050	·28	·17	10·5
Ditto (on Paradise stock)	230	1·050	·20	·12	12·5
Écarlatine (head-grafted on Warner's King, 1906)	1	1·047	·20	·13	8·4
Ditto (on Paradise stock)	493	1·053	·19	·14	13·2
Ditto (ditto)	495	1·050	·12	·11	12·5
Ditto (ditto)	500	1·050	·13	·10	12·5
Eggleton Styre	6	1·046	·22	·15	6·2
Ditto	7	1·051	·30	·16	8·6
Ditto	8	1·062	·31	·18	11·
Ditto	9	1·060	·41	·20	10·
Ditto (on Paradise stock) ..	220	1·050	·13	·16	10·
Ditto (ditto)	221	1·055	·16	·12	11·
Ditto (ditto)	222	1·050	·16	·12	10·

TABLE B—*continued.*

Name of Variety.	Number of Tree.	Composition of Juice, 1913.			
		Specific Gravity.	Malic Acid, per cent.	Tannin, per cent.	Daily Fall in Specific Gravity at 27 deg. C.
Eggleton Styre (on Paradise stock) ..	224	1·054	·15	·12	10·8
Ditto (ditto)	257	1·049	·07	·09	9·8
Fréquin Audièvre (head-grafted on Broadleaf Jersey in 1906) ..	78	1·055	·22	·38	6·1
Ditto (on Paradise stock) ..	85	1·050	·14	·15	12·5
Ditto (ditto)	86	1·052	·13	·15	12·8
Ditto (ditto)	87	1·052	·14	·14	13·
Fréquin Rouge (on Paradise stock) ..	420	1·044	·19	·20	14·7
Ditto (ditto)	422	1·044	·24	·26	11·7
Ditto (ditto)	423	1·046	·21	·33	9·3
Ditto (ditto)	424	1·048	·20	·30	7·8
Ditto (ditto)	425	1·045	·28	·32	9·
Ditto (ditto)	426	1·049	·20	·21	16·5
Ditto (ditto)	427	1·048	·20	·21	19·5
Ditto (ditto)	428	1·047	·20	·28	15·5
Footlands No. 2 (on Paradise stock) ..	101	1·045	·37	·09	5·7
Ditto (ditto)	102	1·043	·36	·16	5·4
Ditto (ditto)	103	1·048	·25	·15	7·
Ditto (ditto)	106	1·051	·33	·14	6·6
Harry Masters (ditto)	135	1·057	·19	·23	9·8
Ditto (ditto)	136	1·046	·14	·22	8·2
Kingston Black	1	1·045	·45	·19	3·7
Ditto	4	1·089	·77	·31	6·8
Ditto	5	1·056	·53	·23	3·3
Kingston Black Improved (on Paradise stock)	260	1·049	·23	·13	9·7
Ditto (ditto)	261	1·049	·31	·17	12·2
Ditto (ditto)	262	1·048	·35	·19	12·
Ditto (ditto)	263	1·050	·37	·20	10·
Ditto (ditto)	264	1·046	·42	·15	11·5
Ditto (ditto)	265	1·051	·36	·17	12·7
Ditto (ditto)	266	1·057	·32	·21	12·
Knotted Kernel	1	1·057	·17	·37	6·
Ditto	2	1·058	·18	·31	8·1
Ditto	3	1·053	·18	·24	6·7
Ditto	4	1·060	·17	·29	8·
Ditto	5	1·061	·19	·38	6·
Ditto	6	1·059	·23	·32	6·8
Ditto	7	1·059	·19	·32	8·7
Ditto	8	1·063	·19	·31	8·5
Ditto	9	1·059	·19	·30	7·5
Ditto	10	1·062	·21	·27	6·6
Ditto (on Paradise stock)	43	1·059	·17	·26	8·5
Ditto (ditto)	77	1·053	·12	·37	4·6
Ditto (ditto)	102	1·057	·21	·43	8·8
Ditto (ditto)	163	1·058	·20	·32	9·2
Major (on Paradise stock)	167	1·064	·14	·38	9·1
Ditto (ditto)	168	1·061	·15	·28	6·1
Médaille d'Or	1	1·065	·26	·83	9·
Ditto	3	1·069	·25	·94	6·4
Ditto	4	1·069	·25	·98	9·8
Ditto	5	1·066	·23	·77	12·4
Ditto	6	1·073	·22	·74	6·7
Ditto	7	1·068	·26	·75	9·2

TABLE B—*continued.*

Name of Variety.	Number of Tree.	Composition of Juice, 1913.			
		Specific Gravity.	Malic Acid, per cent.	Tannin, per cent.	Daily Fall in Specific Gravity at 27 deg.C.
Médaille d'Or	8	1·068	·28	·88	6·
Ditto	9	1·063	·27	·74	9·4
Ditto	10	1·057	·28	·68	4·4
Ditto (on Paradise stock)	58	1·075	·18	1·20	7·8
Ditto (ditto)	59	1·054	·17	·50	6·
Ditto (ditto)	239	1·071	·19	·85	11·4
M. Jacques (head-grafted on Morgan Sweet, 1905)	66	1·051	·33	·38	10·7
M. Jacques No. 1 (on Paradise stock) ..	184	1·050	·07	·22	5·
Ditto (ditto)	185	1·065	·11	·26	8·4
Ditto (ditto)	186	1·075	·16	·26	8·8
Ditto (ditto)	187	1·053	·11	·19	8·8
M. Jacques No. 2 (ditto)	200	1·057	·26	·72	14·2
Ditto (ditto)	201	1·056	·26	·71	11·5
Ditto (ditto)	203	1·059	·21	·66	7·
Ditto (ditto)	204	1·064	·17	1·10	13·
Neverblight (head-grafted on Hardwicks, 1905)	1	1·039	·58	·16	3·3
Ditto (ditto)	2	1·046	·66	·19	3·3
Ditto (ditto, 1906)	3	1·042	·61	·15	3·
Ditto (on Paradise stock)	234	1·039	·40	·16	13·
Ditto (ditto)	235	1·045	·34	·21	10·7
Ditto (ditto)	237	1·043	·38	·14	14·5
Ditto (ditto)	238	1·038	·35	·11	17·5
Ditto (ditto)	239	1·042	·48	·11	11·
Ditto (ditto)	242	1·060	·24	·19	14·
Ditto (ditto)	243	1·064	·16	·19	14·5
Ditto (ditto)	244	1·046	·34	·15	7·5
Ditto (ditto)	245	1·064	·18	·23	14·5
Ditto (ditto)	246	1·059	·23	·26	14·7
Ditto (ditto)	247	1·052	·19	·25	9·6
Philip Norman (on Paradise stock) ..	375	1·043	·10	·20	8·2
Ditto (ditto)	376	1·042	·10	·19	6·4
Ditto (ditto)	377	1·041	·11	·16	8·2
Ditto (ditto)	378	1·049	·13	·25	8·4
Ditto (ditto)	379	1·045	·13	·23	9·
Ditto (ditto)	380	1·045	·13	·24	9·6
Pride of Australia (ditto)	506	1·049	·57	·13	9·8
Ditto (ditto)	507	1·050	·35	·19	21·
Red Manse	1	1·058	·44	·28	7·8
Red Foxwhelp (on Paradise stock) ..	323	1·043	·49	·20	11·7
Red Streak (ditto)	292	1·042	·55	·10	13·2
Ditto (ditto)	293	1·042	·58	·10	13·2
Reinette Obry (head-grafted on Morgan Sweet 1905)	2	1·049	·54	·10	9·8
Ditto (on Paradise stock) ..	306	1·048	·35	·06	12·5
Ditto (ditto)	307	1·049	·50	·13	13·
Ditto (ditto)	308	1·046	·53	·12	11·
Ditto (ditto)	309	1·046	·47	·12	9·2
Ditto (ditto)	310	1·049	·50	·10	9·8
Roussie (on Paradise stock)	483	1·059	·15	·52	9·3
Ditto (ditto)	484	1·059	·19	·65	8·7

TABLE B—*continued.*

Name of Variety.	Number of Tree.	Composition of Juice, 1913.			
		Specific Gravity.	Malic Acid, per cent.	Tannin, per cent.	Daily Fall in Specific Gravity at 27 deg. C.
Royal Jersey (head-grafted on Bramley's Seedling, 1906)	1	1·065	·18	·63	5·6
Ditto (ditto)	3	1·058	·19	·46	6·8
Ditto (ditto)	4	1·054	·21	·45	5·7
Ditto (head-grafted on Broadleaf Jersey, 1906)	1	1·066	·10	·55	6·
Royal Jersey (on Paradise stock) ..	36	1·067	·20	·76	12·4
Ditto (ditto)	95	1·061	·19	·35	10·6
Ditto (ditto)	96	1·061	·17	·33	8·4
Ditto (ditto)	97	1·059	·12	·38	9·8
Ditto (ditto)	98	1·055	·13	·40	6·4
Ditto (ditto)	99	1·054	·13	·36	6·3
Ditto (ditto)	100	1·054	·12	·38	6·6
Ditto (Croft's) (ditto)	39	1·062	·17	·31	8·4
Ditto (ditto) (ditto)	42	1·058	·14	·31	8·8
Ditto (ditto) (ditto)	45	1·054	·11	·31	8·2
Royal Wilding (on Paradise stock) ..	4	1·058	·10	·30	11·
Ditto (ditto)	5	1·055	·13	·27	10·
Ditto (ditto)	6	1·056	·09	·28	10·
Ditto (ditto)	7	1·055	·07	·32	7·1
Ditto (ditto)	8	1·054	·07	·27	8·
Ditto (ditto)	9	1·056	·08	·31	10·7
Ditto (ditto)	10	1·056	·09	·30	10·5
Ditto (ditto)	11	1·055	·08	·32	9·7
Silver Cup (ditto)	163	1·054	·12	·27	7·7
Skyrme's Kernel	1	1·058	·50	·31	5·7
Ditto	7	1·059	·50	·27	8·
Ditto (on Paradise stock)	326	1·053	·33	·32	12·
Strawberry Norman	1	1·057	·30	·40	6·5
Ditto	3	1·057	·27	·39	5·2
Ditto	4	1·055	·29	·46	7·
Ditto	6	1·051	·31	·45	4·7
Ditto	7	1·056	·31	·49	5·7
Ditto	8	1·058	·30	·53	5·7
Ditto	9	1·057	·34	·45	6·
Ditto	10	1·059	·36	·57	6·2
Ditto (on Paradise stock)	82	1·054	·16	·40	11·5
Sweet Alford (head-grafted on King of the Pippins, 1906)	5	1·061	·19	·22	5·1
Ditto (head-grafted on Ecklinville, 1906)	6	1·061	·31	·19	4·7
Ditto (ditto)	7	1·061	·15	·23	3·6
Ditto (ditto)	8	1·058	·16	·19	4·
Ditto (ditto)	9	1·058	·18	·10	5·5
Ditto (ditto	10	1·062	·22	·20	4·4
Ditto (head-grafted on Broadleaf Jersey, 1906)	182	1·060	·27	·15	4·4
Sweet Bay (on Paradise stock)	395	1·053	·15	·15	10·6
Taylor's Spie (ditto)	419	1·050	·54	·18	18·
The Bell (ditto)	387	1·055	·18	·13	11·3
Ditto (ditto)	389	1·056	·15	·13	9·6
Thomas Hunt (ditto)	400	1·056	·18	·11	18·5
Ditto (ditto)	402	1·058	·14	·10	19·
White Bache (ditto)	33	1·068	·26	·74	13·6

TABLE B—*continued.*

Name of Variety.	Number of Tree.	Composition of Juice, 1913.			
		Specific Gravity.	Malic Acid, per cent.	Tannin, per cent.	Daily Fall in Specific Gravity at 27 Deg. C.
White Close Pippin (on Paradise Stock)	353	1·046	·12	·21	·11
Ditto (ditto)	354	1·045	·09	·30	9·7
White Jersey (on Paradise stock) ..	12	1·051	·14	·22	5·1
Ditto (ditto)	14	1·052	·13	·18	7·
Ditto (ditto)	77	1·040	·16	·23	5·5
White Styre (ditto)	312	1·055	·28	·26	12·
Ditto (ditto)	313	1·050	·14	·17	9·
Ditto (ditto)	318	1·048	·47	·10	12·
Wm. Anderson (ditto)	437	1·040	·19	·11	6·4
Ditto (ditto)	438	1·033	·19	·11	5·6
Ditto (ditto)	439	1·039	·23	·10	9·3
Woolston Spice (ditto)	300	1·046	·18	·28	11·
Ditto (ditto)	302	1·051	·16	·27	9·8
Ditto (ditto)	303	1·056	·11	·30	8·2
Yarlington Mill (head-grafted on Hardwicks, 1906)	118	1·050	·25	·28	5·6
Ditto (on Paradise stock)	91	1·054	·22	·21	9·
Ditto (ditto)	92	1·052	·24	·22	8·6
Ditto (ditto)	93	1·052	·16	·22	8·8
Yeovil Sour (ditto)	269	1·046	·38	·16	7·7
Ditto (ditto)	270	1·045	·24	·19	8·2
Ditto (ditto)	271	1·042	·45	·13	8·7

INVESTIGATIONS ON BORDEAUX MIXTURES.

By B. T. P. Barker and C. T. Gimingham.

The continually increasing use of spray fluids for the control of insect and fungoid pests as a regular part of the routine work of farmers and gardeners draws attention to the need for a systematic investigation of the mode of action of those which are most commonly used. During the past few years we have made a study of Bordeaux mixture from this point of view ; and this article forms a summary of the main points of the work.*

It is somewhat remarkable in view of the importance of the subject that until comparatively recently the chemistry of Bordeaux mixture had received but little attention. A comprehensive literature exists dealing with various connected problems, and many theories have been put forward to explain the fungicidal action, but, prior to 1907, all the work had been carried out without an adequate investigation of the chemistry of the compounds involved. The statement that the insoluble copper precipitate, which is formed on the addition of the lime to the copper sulphate, consisted of copper hydroxide was for the most part accepted as correct, though one or two writers refer to the probability of basic sulphates also being present.

Pickering has now shown (*Jour. Chem. Soc.* 1907, p. 1988) that the addition of lime in gradually increasing amounts to a solution of copper sulphate results in the formation, not of copper hydroxide at all, but of a series of basic sulphates of copper. In ordinary Bordeaux mixture (*i.e.*, made from equal weights of copper sulphate and lime) the formula of the final compound present is given as 10 CuO, SO_3, 3 CaO in presence of large excess of free lime ; whereas if no

* The following are the original papers :—

Gimingham : "The Action of Carbon Dioxide on Bordeaux Mixtures," J. Agric. Sci. IV. 69.

Barker and Gimingham "The Fungicidal Action of Bordeaux Mixtures," J. Agric. Sci. IV. 76.

Barker and Gimingham : "Further Observations on the Fungicidal Action of Bordeaux Mixtures," J. Agric. Sci. VI.

Barker and Gimingham : "The Action of Bordeaux Mixture on the Plant" Ann. Econ. Biology I.

(*At the time of writing the two latter papers are still in the press.*)

excess of lime is present, the composition of the compound may be either 4 CuO, SO_3, 5 CuO, SO_3 or 10 CuO, SO_3 depending on the proportion of lime water added. In the same paper Pickering shows that the action of carbon dioxide on these compounds is to bring copper into solution as sulphate. He gives the following equation :—

$$10\,CuO,\,SO_3 + 4{\cdot}5\,CO_2 = 4{\cdot}5\,(CuO)_2\,CO_2 + CuSO_4$$

and considers that in practice, soluble copper will be produced in this way by the action of atmospheric carbon dioxide.

This suggestion brings us directly to the much debated question of the nature of the fungicidal action of Bordeaux mixtures. It is not difficult to understand the direct piosonous action of *soluble* copper compounds, but in Bordeaux mixture the copper is present solely in an *insoluble* form, and in order to explain its action in practice many theories have been brought forward.

There appear to be three possible alternatives :—

(1) That a purely chemical process is concerned, soluble copper being produced by atmospheric agencies, especially by the CO_2 of the air.

(2) That the foliage of the sprayed plants exercises a solvent action on the copper deposit.

(3) That the fungus itself dissolves sufficient of the insoluble copper deposit to cause its death.

Millardet and Gayon (*J. d'Agr. Pract.* 1887) were the first to suggest the agency of atmospheric carbon dioxide in bringing copper into solution, and this view has been elaborated by Pickering. To the copper sulphate formed according to the equation given above he attributes the main fungicidal action of Bordeaux mixtures. This explanation is based on a series of experiments (*see* 11*th Rpt. Woburn Expt. Fruit Farm* 1910 : *J. Agric. Sci.* III., 171) upon the action of a stream of CO_2 on mixtures of copper sulphate and lime water in different proportions. When the proportions employed were such as to form the compounds 4 CuO, SO_3 or 10 CuO, SO_3, the action of CO_2 brought copper into solution rapidly. When ordinary Bordeaux mixture was used (large excess of lime), very little copper appeared in solution until all the free lime had been carbonated. Pickering therefore considers that Bordeaux mixtures made without excess of lime will be more efficient than the ordinary mixture.

In the course of some work on the subject, it was found that all the copper brought into solution by the action of CO_2 for a short length of time on the compound 10 CuO, SO_3 was entirely reprecipitated on removal of the CO_2. The copper sulphate set free according to Pickering's equation is really removed from solution as it is formed and the soluble copper actually found in these experi-

ments is in the form of a carbonate dissolved in the CO_2 solution which precipitates out as the gas escapes. It can be shown that copper sulphate in presence of unchanged 10 CuO, SO_3 combines, up to a certain amount, to form a lower basic sulphate and only whilst there is a large excess of CO_2 (such as could hardly occur out-of-doors) is an appreciable amount of copper brought into solution ; and only under those conditions would any copper so dissolved remain in solution. In view of these observations it is difficult to see how in practice any soluble copper would be produced by the action of the CO_2 in the air. Further experiments designed to test the theory under conditions more like those actually found in practice lead to the conclusion that " although the action of CO_2 in excess upon the compounds present in Bordeaux mixtures brings copper into solution, yet it appears impossible to assign the fungicidal action to copper sulphate liberated by *atmospheric* carbon dioxide." Some alternative to this purely chemical explanation seems necessary.

With regard to the second of the headings mentioned above—a solvent action by the sprayed foliage—the whole of the evidence obtained goes to show that *uninjured* leaves of most ordinary plants do not exert any such solvent power. On the other hand, *injured* foliage unquestionably does possess a distinct solvent action, even although the injuries may be almost microscopic. This is an important point since, certainly from the middle of the summer onwards, it is very difficult to find any number of leaves which are perfectly free from injuries or abrasions of one sort or another, due to insect attacks, to wind damage or other causes. Hence the production of some soluble copper on sprayed trees by excretions from injuries is a factor to be taken account of in this connection ; and it is worth remarking that the " scorching " which so often follows spraying is in all probability started mainly by copper dissolved in this manner.

The possibility of a direct solvent action between the fungus itself and the Bordeaux mixture precipitate, though frequently suggested, could not be said to have been demonstrated. Experiments were, therefore, made with the object of gaining further information upon this point. The action of Bordeaux mixture, with no excess of lime present, and of the filtrate from the mixture, upon spores of various fungi (*Nectria*, *Puccinia* and *Sclerotinia*) has been investigated ; and the results furnish strong evidence in favour of the view " that certain fungi at least are able to act upon the insoluble copper compounds sufficiently to poison themselves, *provided they are associated closely enough with it*." The question of distance between the copper particles and the fungus is the matter of prime importance. By the use of diffusion tubes, in order to prevent direct contact between the copper particles and the spores,

it was shown that the latter apparently exerted no appreciable solvent action at a distance from the copper nor did the minute traces of that substance which are present in solution act as a cumulative poison, the suggestion favoured by Pickering in a more recent paper (*J. Agric. Sci.* 1912, IV., 273).

It seems reasonable to suppose, then, that in practice, when the fungus is in sufficiently close contact with one or more particles of the insoluble copper compound, it will itself dissolve and absorb sufficient of the copper to produce a fatal result. There appears to be no general atmospheric action by which copper becomes soluble, the solvent action of the fungus being effective only at very short range. Germination and growth of the fungus spore may occur in the immediate vicinity of the copper compound so long as it is not quite close enough for copper to be dissolved. Evidently, therefore, it is of the greatest importance in practical spraying to cover the foliage with the mixture as completely as possible.

These conclusions were drawn mainly from experiments in which the behaviour of various types of fungus spores towards the Bordeaux mixture deposit was observed, and more recent work has served to confirm and extend them. The experiments were repeated with numerous modifications and the results have demonstrated the excretion of substances from thin-walled living fungus cells which have a solvent action on the insoluble copper compounds of Bordeaux mixture, the copper so rendered soluble being absorbed with toxic effect.

Further experiments with thick-walled spores have also confirmed the earlier results with uredospores of *Puccinia*.

We have therefore as a result of these experiments definite evidence of a solvent action on the part of the living cell, the conditions determining the toxic effect being the quantity of the solvent substances passing out of the cell, the distance between the cell and the nearest particle of the copper compound and the amount of the latter within the sphere of action. In addition, the time factor must be taken into account. If the rate of growth of the cell and of the formation of new cells exceeds the rate of production and absorption of the toxic dose of dissolved copper, death of the organism will not occur.

In order to obtain further light on the subject, the action of other types of living plant cells upon the copper compounds has been studied. In the first place the fine root-hairs on the roots of seedling plants were utilised, beans and peas being employed in many experiments. Such root-hairs may, in many respects, be considered as types of cells comparable with the germ-tubes of fungus spores or the cells of actively growing hyphæ. The results here were exactly analogous to those with fungus spores: contact with the copper compound destroyed the root-hairs, whilst those not actually touching escaped all injury.

The method adopted did not cause particles of the basic copper sulphate to adhere to all of the root-hairs. Hence the differences in the results observed. If the injurious action was due to the production of soluble copper by agencies other than the living cell itself, the whole root-hair system should have been more or less equally affected instead of showing the extreme variations recorded.

Further, if the Bordeaux mixture precipitate is allowed to settle and two seedlings are placed in the same vessel so that one has its root dipping into the precipitate at the bottom whilst the root of the other remains in the clear liquid above, it is found that after 24 hours many of the root-hairs of the former are killed, whilst those of the latter are all uninjured.

It is evident therefore that it is the direct contact between the thin-walled root-hair and the basic copper sulphate which causes the death of the cell within a few hours.

Not only the root-hairs but also the actual surface of the root was blackened and injured just where the copper compound touched it and not elsewhere. If the root tip of, for example, a bean seedling rests in a pasty mass of the basic sulphate no further apical growth occurs. The portion of the primary root above the paste elongates and new secondary roots arise laterally from that region. These develop naturally until in their normal downward direction they strike the paste, when they suffer the fate of the primary root. The same kind of thing is repeated until in the end the whole root system is represented by a short knotted and blackened stump.

These points can be exceedingly well demonstrated by an experiment carried out with mustard seedlings. Bordeaux mixture was allowed to settle and the pasty mass of the copper compounds at the bottom spread on a strip of flannel in such a way that the surface consisted of portions covered with the paste alternating with untreated portions. The whole surface was then sown evenly with mustard seeds and the flannel strip kept moist by dipping the ends in water. In the course of a day or two it was found that all the seeds on the treated areas were killed before, or immediately after, germination, while on the untreated areas vigorous growth took place and a plentiful crop of young mustard plants sprang up. Those seeds lying just on the junction of a treated and untreated area grew into healthy seedlings provided the young root emerged on the side remote from the Bordeaux mixture paste; on the other hand, if the root grew at once into the paste death resulted. Good growth also was obtained if the seeds were sown on the opposite side of a treated area, the seedlings then being removed from the paste only by the slight thickness of the flannel. Further, the seedlings grew freely and vigorously if distributed over the outside of a diffusion tube containing the basic copper sulphate paste. It was evident that copper was dis-

solved only on actual contact between the copper compound and the growing root tip.

In all cases the injurious action of the paste on living cells is entirely local and cannot be explained as a result of the production of soluble copper by atmospheric agencies. The action is not limited to the basic copper sulphate formed in the " no-excess-lime " Bordeaux mixture (10 Cu O, S O_3), though this compound has been used in the majority of the experiments. The same results are obtained with the compound present in ordinary Bordeaux mixture (10 Cu O, S O_3, 3Ca O) and with copper carbonate. With the last-mentioned substance however the solvent action of the cells is apparently less vigorous.

* * * * *

The action of cell walls of an entirely different type has been studied by an investigation of the interaction between the Bordeaux mixture and the leaf cells to which it is applied in practical spraying.

In this work it became apparent at a very early stage that trustworthy results could only be obtained when the portion of the leaf selected for the test possessed a cuticular surface absolutely free from injury of any kind. Emphasis must be laid upon this point, since the risk of abnormal results is very great if any part of the cuticle coming within the area of application of the fungicide has suffered damage.

In the first place, in order to obtain evidence with regard to the extent to which the cuticularised walls of epidermal cells are impermeable, a number of healthy summer leaves of various varieties of apples (as far as possible free from visible injury) were immersed in copper sulphate solutions (1, 5 and 10 per cent.) for periods varying from five minutes to twenty-four hours. It was remarkable how very little general injury to the surface of the leaves resulted. The damage was invariably restricted to separate areas starting from centres irregularly distributed over the surface of the leaf and could be increased by prolonging the immersion. The epidermis of the leaf as a whole is certainly not appreciably permeable : there is no general and simultaneous injury to the whole leaf surface.

Corresponding experiments were made with Bordeaux mixtures and with a paste of the basic sulphate 10 Cu O, S O_3. As was to be expected there was little or no effect upon the general surface of the leaf. Only at spots where an injury (natural or made purposely) allowed contact between the copper compound and the inner thin-walled cells was there any noticeable discolouration of tissue or " scorching." On really uninjured leaves the hairs on the under surface were the only cells which showed the least trace of any absorption of copper ; and this applies both to leaves treated with the basic sulphate paste or immersed in copper sulphate solutions.

Several varieties of apples were tested in this way with no significant differences in the results. It should also be recorded here that Mr. S. P. Wiltshire after a long series of examinations and measurements could find no sort of correlation between the thickness of the cuticle of the leaves of various varieties of apples and pears and their known susceptibility to scorching by Bordeaux mixture.

These experiments may be considered to demonstrate conclusively that the cuticularised walls of the epidermal cells of apple leaves in the summer stage—the importance of this reservation will be seen presently—are examples of typical impermeable walls. Their behaviour in relation to Bordeaux mixture as compared with that of unchanged cellulose walls, such as those of the roothairs and roots of seedlings, may be considered analogous to that of certain thick-walled resistant fungus spores in comparison with thin-walled germ tubes and actively growing hyphæ. It is true that the impermeability of the wall of a fungus spore cannot be demonstrated so conclusively as that of a cuticularised epidermal wall; but it will probably not be disputed that it is the fungus equivalent for a cuticle, and therefore more or less impermeable so long as the spore is in a resting condition.

From the results here recorded it may then be concluded that :—

(1) Living cells with readily permeable walls of the unchanged cellulose type or its equivalent are able to produce and absorb soluble copper from insoluble compounds such as the basic sulphates.

(2) The area over which a single cell can exert the solvent action is limited by the size of the cell or, perhaps, more accurately, by the quantity of the solvent diffusing from it. Groups of cells acting in conjunction may cause appreciable action over a wider area than an isolated cell singly.

(3) The fate of the organism depends upon the relation between the amount of soluble copper produced and absorbed and the rate of growth of the organism. This is a significant point in connection with practical spraying, since it explains why there may be at times little check to the growth of a parasitic fungus after spraying, especially when the parasite has once gained a footing on the host-plant.

(4) Cells with walls of an impermeable character possess no such power of solvent action upon insoluble copper compounds. In the case of apple leaves only when there is injury to the cuticle sufficiently recent to prevent occlusion, or when there is some radical alteration in its nature,

is soluble copper produced, with attendant " scorching " or local injury of the exposed thin-walled cells of the subjacent tissues.

It is evident therefore that the nature of the cell wall is the determinative factor in the matter of direct action of the cell upon the Bordeaux compounds.

* * * * *

In addition to the work on the fungicidal action, attention has been given to the questions of (*a*) spray injury or " scorching " of foliage by Bordeaux mixtures, and (*b*) the penetration of copper into the plant. With regard to foliage injury by Bordeaux mixtures it has already been suggested that some importance should be attributed to the influence of exudations from damaged spots on the leaves. In order to investigate this point more fully, it was necessary to grow apple foliage specially protected from liability to damage, since, as is generally recognised, it is almost impossible to find any number of apple leaves, when grown under ordinary conditions, which are really free from minute injuries of one sort or another. This was done by enclosing a number of one-year-old apple seedlings, before the leaf buds opened, in muslin cages supported on light frames. The plants were kept in a cool greenhouse and the new foliage put out was thus almost completely protected from the chance of damage by bruising or by insect attacks.

A series of experiments was then carried out in which the effect of various types of Bordeaux mixture upon such undamaged foliage was compared with the effect when the foliage was first artificially damaged by scratching or bruising. The result was that on the day following treatment there was not the least trace of injury or scorching on the plants with undamaged foliage whilst those which were damaged showed serious injury typical of Bordeaux scorch which had quite obviously begun at the artificially damaged spots and afterwards spread. The " no-excess-lime "* mixture caused injury very much worse in character than the ordinary Bordeaux mixture. A control plant first damaged and then sprayed with water showed a browning along the extreme edges of scratches and spots, but no spreading of injury. It was also found, as was to be expected, that these effects were very much more marked when the Bordeaux was put on soon after the damaging of the leaves. If an interval was allowed the injury was markedly less severe.

In another series aphides were introduced into the muslin cage surrounding the foliage and allowed to increase until many of the

* This expression is used to indicate the mixture prepared by the addition of just enough lime-water to the copper sulphate to precipitate the whole of the copper as the compound 10 CuO, SO_3.

leaves were badly infested; the plants thus damaged were then covered with the "no-excess-lime" mixture. The result was very bad scorching, largely confined to the underside of the leaves where they were most damaged by aphis.

We have then definite evidence of the importance of the presence of artificially or naturally damaged foliage in considered scorching by Bordeaux mixture; and there is no doubt whatever that even slight injuries to the leaf cuticle, such as are caused by insects, fungi or wind bruising, if they have not had time to dry up, play an important part.

The simplest explanation of the enhanced scorching of damaged as compared with undamaged foliage is, that soluble copper compounds* are produced by the solvent action of exudations from the injured cells and from those underlying which are exposed by the injury and that these are then absorbed through the thin-walled cells of the internal tissues of the leaf. It is then easy to understand the gradual spreading of the spots from a centre which is observed in most cases of Bordeaux scorch. Serious scorching occurring several days or even weeks after the actual spraying is probably to be accounted for by rough weather causing damage to the foliage or by a serious insect attack. Again the general opinion of practical men† that Bordeaux injury is determined by the weather conditions at the time of spraying, and that the injury is most serious when rain immediately follows the spraying, fits in well with the view here suggested, since in wet weather any injuries present will heal over much less quickly and will therefore be capable of dissolving copper during a longer period.

Whether the presence of injuries is the sole cause or whether Bordeaux mixture does ever cause scorching by itself on *undamaged* leaves is not an easy point to settle satisfactorily. It appears that, as recorded above, there is no noticeable scorching of foliage which has been carefully protected; and indeed we have a good deal of evidence emphasizing the impenetrability of the undamaged leaf cuticle of ordinary healthy summer foliage. For example, the general surface of healthy leaves stands immersion in 5 per cent. or even 10 per cent. copper sulphate solution remarkably well, and indeed, the general conclusion which may be drawn from a large number of experiments on the effect of solutions of copper sulphate upon the foliage of different varieties of apple is that, except where the leaves are originally damaged in some way, a short time of contact with a weak solution causes little or no immediate injury, though a longer time of contact may initiate injury to the

* Soluble copper produced in such manner may, as previously suggested, also act fungicidally.

† Confirmed experimentally by Crandall and by Hedrick in America.

under surface. Even, however, after immersion for one hour in a 5 per cent. solution or for half an hour in a 10 per cent. solution the general surface of healthy leaves is not seriously injured. It must be mentioned, however, that with all leaves, damaged or undamaged, treatment with copper sulphate affected the hairs on the under surface, resulting in slight yellowish discolouration which on close examination was found to be due to the staining of the cell walls.

These observations apply, however, to summer foliage only; and when similar experiments are tried in the late autumn the results are rather different. The effect of covering autumn leaves, while still on the trees, with "no-excess-lime" Bordeaux mixture is to cause considerable and apparently general scorching over most of the leaf surface accompanied by premature defoliation. When ordinary Bordeaux mixture (containing excess lime) is used, there is more scorching than is noticed in the summer, but the action is not severe. With 5 per cent. copper sulphate solution the leaves very soon shrivel up and drop, and the presence of copper can be traced inside the stem lower down than the parts actually immersed. There is in these cases apparently a general scorching independent of the presence of visible injuries and of a somewhat different character to that which occurs in the summer. The cuticularised walls of the cells are found to be stained a pale greenish colour, in a manner similar to the leaf-hairs already mentioned.

It may be said in conclusion that the evidence seems complete as regards the part played by injuries to the leaves in causing scorching of apple foliage following spraying with Bordeaux mixture; whilst under some conditions it would seem that scorching may also occur over the general surface of the leaf and unconnected with the occurrence of injuries, though this is less certain. No doubt such action, if it takes place, is more important in foliage such as peach and apricot where either the cuticle as a whole or certain parts of the leaf surface appear to be less resistant than is the case with the apple.

Turning now to the question of the penetration of copper from Bordeaux mixture into the plant, *damaged* apple foliage which has been sprayed and which shows any signs of scorching has always been found to contain some copper. On the other hand, with really uninjured summer apple foliage, copper has not been detected in the ash. It would appear that there is no absorption of copper through the normal cuticle of a healthy apple leaf though autumnal changes may lead to a partial change in the nature of the leaf surface resulting in a varying amount of action on Bordeaux mixture.

With sprayed *potato* foliage the case is rather different. There is certainly some absorption of copper by healthy leaves, but seldom any noticeable injury to the cuticle. Copper absorbed in such a manner appears to be rapidly translocated and dispersed without

harm to the living cells through which it passes. Possibly the removal is sufficiently rapid to prevent the toxic dose being reached at any one point. It was also found that by growing potatoes or beans in soil mixed with Bordeaux mixture, some copper was absorbed by the roots and translocated to the aerial parts of the plant.

The question of the influence of the copper in potato and other foliage on the power of resistance to fungoid attack is still under investigation.

The results of these observations on the absorption of copper by the plant from the insoluble copper compounds of Bordeaux mixtures may be summarised as follows :—

Cells with readily permeable walls (such as germ tubes of fungus spores, root-hairs, the interior tissues of leaves, etc.), exert a considerable solvent action on the particles of these copper compounds with which they may come into contact. There is rapid absorption of such dissolved copper followed by death of the cells.

The amount of interaction, if any, between other types of cells and the copper compounds is determined by the nature of the cell-wall. Direct absorption of copper by leaves of certain types takes place with or without local injury depending on the nature of the leaf surface. Translocation of the absorbed copper to other parts of the plant may follow.

Copper may be absorbed through the roots of certain plants (potatoes, beans) with local injury to the root. This absorbed copper can be translocated to the aerial parts of the plant without injury to the cells through which it passes.

WIND SCORCH OF APPLE FOLIAGE.

By B. T. P. Barker and C. T. Gimingham.

For several seasons the foliage of many of the varieties of apple trees at the Institute has suffered severely from scorching. The browned or scorched regions are mostly located along the margin of the leaves, although affected patches occur frequently also at any part of the leaf surface. A close microscopical examination of the affected areas has repeatedly been made to ascertain whether a parasitic fungus or other possible cause of the trouble was present. Although occasionally fungi have been found, especially in the later stages of the disease, no single form is invariably present; and there is little doubt that the scorching is due to physiological causes and quite independent of the action of a parasite. The possibility of the damage being produced by the burning action of spray fluids was considered: but, since it frequently occurred as freely on unsprayed as on sprayed trees, it was obviously not a spray scorch. Nor did the general character of the affected areas correspond at all with that of a sun scald. The clue to the cause was obtained last June during a visit of inspection to the fruit plantations of Mr. J. M. Young, at Shippea Hill, West Suffolk. The disease was very marked on certain varieties there at that time, and Mr. Young suggested that the wind was responsible for the trouble by causing constant rubbing of adjacent leaves on each other. The movements of the foliage in the breeze were closely watched, and it became clearly evident that this suggestion was correct.

Since that time the behaviour of individual leaves on trees at the Institute has been observed, and the development of the scorching has been traced from the earliest stages. Taking a definite example, the history proceeds more or less on the following lines. Two leaves in quite an early stage of development are situated, maybe on the same, or maybe on adjacent, young shoots of the current season's growth, in such a way that the margin or the tip of the one rests lightly on some point of the surface of the other. Even a comparatively gentle breeze causes the rough edge of the former to oscillate constantly or intermittently against the latter. The oscillation evidently causes local irritation of the cells of both

leaves at the points of contact, and abnormal changes resulting in an unhealthy condition of the cells ensue. The first outward sign of trouble is the development of a slightly purplish coloration at those points in the place of the normal healthy green colour, the appearance suggesting a slight bruise. Later the discoloured patches begin to turn brown, and eventually dry up and present the typical scorched character. By this time the growth of the shoots bearing the leaves has probably extended to such a length that the one leaf has been carried entirely out of range of the other: and anyone observing them at this stage would have no suspicion that the scorched areas on the two were in any way related.

Naturally the habit of a variety will largely determine its susceptibility to this disease, the less rigid and more pendulous types clearly being likely to suffer most.

It is probable that a great deal of the scorching troubles on foliage following the application of spray fluids may be closely connected with wind scorch, since the early stages of the latter cause leaf injury not easily detected, and, as shown in our work on Bordeaux mixture, spray scorching results very largely, if not entirely, from previous leaf injury.

NOTES ON WINTER AND SUMMER SPRAY FLUIDS.

By A. H. Lees.

Winter Spray Fluids.—Winter spray fluids may be divided into two kinds, viz., those that seek to kill by direct chemical action, and those which aim at covering the tree with a thick coating of material that shall mechanically prevent egg hatching. Of the latter lime and salt is the type. This wash is made up of lime, salt and water in the proportion of 20lbs. of lime to 2lbs. of salt and 10 gallons of water. Many growers leave out the salt and report results as good as with it.

Such a covering wash must fulfil four conditions :—

(1) It must have body enough to give a good covering coat.
(2) It must be so adhesive that it will not be washed off by rain.
(3) It should not flake off when dry.
(4) It must be moderate in cost.

If a fungicide can be combined with it, so much the better.

The results of lime washes as given by growers show some variance. Some have obtained a crop of apples where they never had one before owing to the attacks of apple psylla, and other growers declare they have had no benefit at all.

The action of lime washes is supposed to be mechanical rather than chemical, *i.e.*, its good effects are supposed to be due to the thick covering on the egg which prevents egress of the feeble larva rather than to chemical action on the egg itself. Growers, however, assert that they have seen young psyllas walking about with a lime coating on their backs, which makes it appear as if the action is not only mechanical. From experiments recently done on a laboratory scab it would appear that the action is both to mechanical and physiological causes.

Last year at Long Ashton various washes were tried on a laboratory scale to test their covering and adhesive properties. Of these the most successful was a mixture of whiting and size; but its costliness effectually bars it from use on a large scale. Other variants of lime wash, such as lime and tallow, and lime and

water-glass, proved no more successful than lime alone. A certain amount of work was done with these lime variants on plantations in various counties; but the unevenness of infection and different susceptibilities to attack of the few trees that could be sprayed made it difficult to get definite results.

This year an attempt was made to find a glue considerably cheaper than size, whose cost is about a shilling a pound. The lowest price obtainable was 4d. a pound and this glue used at the strength prevously employed for size caused the wash to come out at over 4d. a gallon. If used at a less strength than one pound to the gallon the wash had not sufficient covering power so that some body giving the extra desired covering power was sought. After some amount of laboratory experiments a mixture was found working out at 2d. a gallon, which, though expensive, was thought good enough to be tried in the field. Accordingly this spring it has been tried at Long Ashton, and also at centres in Gloucestershire, Worcestershire and Herefordshire.

In addition to this whiting wash attempts were made to find some ingredient to add to lime to make it adhere better.

A considerable number of substances were tried, the full details of which will be published in a subsequent paper. The investigation was hampered by the difficulty of obtaining substances sufficiently cheaply as the amounts of wash used on apple trees may vary from three to ten gallons, or even more.

The various methods of slaking lime have been investigated and have shown some diversity in covering and sticking power. The best covering power was obtained by the use of hot water, and the best sticking power by allowing the lime to stand for a day before using. The addition of substances to lime wash very often lowered the adhesive powers. All substances of a greasy or oily nature were specially noticeable in this respect, the resulting mixture when dry being usually powdery and soft. Pickering obtained a similar result when he made mixtures of lime wash and heavy paraffin oils. Glue also gave disappointing results. As the result of laboratory trials four variants of lime mixture were tried in the open at Long Ashton.

These have stood the weather better than simple lime wash, but are probably not so good as the whiting mixture. They are, however, only about half the price and are easier to make.

Several other variants are yet to be tried, their application having been postponed owing to the lateness of the season.

Summer Spray Fluids.—During the summer work has been started on contact washes. For killing by contact the first thing necessary is wetting power. This is largely dependent on a low surface tension. It is quite possible to prepare a thoroughly poisonous wash and yet in actual practice to find that its killing power is small. Many

brands of nicotine show this phenomenon. They have very little wetting power and consequently small killing power. If 1 per cent. soft soap is added, their wetting power is greatly increased and they become exceedingly effective.

Proprietary washes often appear to lack wetting power, though this is of first importance for success. Many aphides are mealy and are scarcely wetted by ordinary water solutions. A low surface tension is also of advantage in causing drops to spread on a leaf, thus causing a more thorough wetness of the tree than could otherwise be obtained. Soft soap is the most useful common substance to lower surface tension. Waters of average hardness require 1 per cent. (1lb. in 10 gallons) to produce the required results. Harder waters would need slightly more.

The surface tension can be still further reduced by the use of paraffin. Paraffin when not properly emulsified in a soap solution is liable to cause burning, even when present in comparatively small quantities. When emulsified and not used stronger than 2 per cent., very little burning occurs. For an ordinary aphicide 1 per cent. of paraffin was found sufficient, while for penetrating the wax colonies of the Woolly Aphis 2 per cent. was required.

The method for making is as follows :—

Formula :

Soft soap 1 lb.
Paraffin 1 pint.
Water 10 gallons.

The soft soap is dissolved in a gallon of boiling water and the paraffin is then churned into the hot liquor by means of a garden syringe with a rose on it. The rose breaks up the paraffin into small drops which are then prevented by the soft soap solution from re-uniting, so that a perfect emulsion is formed.

The two important points are to use the soft soap solution when hot, and to spray the paraffin vigorously into the liquid. Simple stirring is ineffective and highly dangerous, as such a mixture will certainly cause bad burning.

When the paraffin is emulsified, the other 9 gallons of water are added, which gives the required 1 per cent. wash.

NOTES ON INSECT PESTS OF FRUIT TREES.

By A. H. Lees.

Big Bud Disease of Black Currants.—This disease has been known in this country for over half a century, but has only recently become serious. At first bad attacks were confined to the newer heavy bearing and comparatively sappy varieties, while the old established sorts which were more woody in growth and also less productive remained free. It is difficult to say what this was due to. From the fact that these old kinds are now as badly attacked as the new it would appear that the freedom of attack was due more to the older kinds being grown in comparatively isolated situations, such as cottage gardens, than to any real disease resisting quality of the plants themselves. At intervals so-called immune kinds, generally distinguished by their strong growth, have been introduced, only to fall victims to the disease after a short period of culture. Boskoop Giant is an example of these.

Now no variety can claim freedom from the disease, though the French varieties have proved themselves the best in this respect.

In general the green-budded varieties are more susceptible than the red. There appears to be no hope of obtaining a disease-proof variety till breeding work is undertaken on Mendelian principles.

The general facts of the life history are well known. The greater part of the year is spent by the mite in the closed buds of the currant and only a comparatively short period is spent away from protection, and therefore open to treatment by spray fluids. Young buds just formed may be infected with the mite as early as the middle of June, and it is possible and even probable that infection takes place earlier. At any rate mites may be discovered at that time in the newly formed buds, though it is only towards the end of the year that eggs are found in any abundance. The mites therefore in the winter appear to be safe from human attack, since no spray fluid which would not destroy the buds is likely to kill them. In spring, however, the " big " buds infected by the mite begin to open, and swarms of mites emigrate from the now dying bud. They may be found in greatest numbers just outside a big bud, but they are also present in quantity on the leaves and flowers. In this latter position, it is supposed, they meet with various flying insects visiting

the flowers, and to the hairs of these insects they fasten themselves and so obtain a further distribution to other bushes.

At the same time they enter new hitherto uninfected buds of the same bush. This migration certainly continues for six or eight weeks and it is possible that it extends over a longer period.

There is reason to suppose that the life history is not yet completely known. If the only winter stage was that in the buds, it should be possible greatly to reduce the amount of disease in a plantation, if not to stamp it out, by cutting the bushes down to the ground and removing all buds except the minute dormant buds. This has been done by growers, but their general experience is that the disease is as bad next year. Of this there could be two explanations. The first assumes some other wintering place besides the inside of the bud. Two places suggest themselves, the ground and the bark of the bushes, which offers a good shelter in the natural cracks that occur there. No one has yet succeeded in finding mites or eggs in samples of soil, but this is hardly proof that they do not occur there, as it is a matter of extreme difficulty to find such small objects amongst the mass of small particles of a soil sample. They have been found on the bark at the base of bushes by Theobald, in autumn, and they may endure the winter in that position. A second explanation may be found in re-infection of the cut down bushes from untreated infected black currants in the vicinity. It is impossible to say how far infection may be carried. Infection often seems very irregular, bushes immediately surrounding an infected bush often remaining free while others more distant become infected. Re-infection, therefore, offers a possible explanation of the non-success of cut down bushes. The experiments on a small scale that have been started at Long Ashton seem to favour this explanation, as the most highly infected cut down bushes stand nearest the untreated material.

To combat the disease two general methods suggest themselves, viz., cultural and spraying.

Some growers have said that plantations could be kept comparatively clear if they were well manured. Manuring on a small scale has been adopted at Long Ashton ; but neither a full artificial manure nor farmyard, appeared to influence the susceptibility to attack. Thinning the bush and tipping to induce the formation of short twigs were also tried, but without striking effect.

The second method, that of spraying, is what has hitherto been employed by growers, when any treatment at all has been tried.

Lime and sulphur dusted on to the bushes was suggested by Collinge and has been tried by various growers. The treatment necessitates three applications at about a fortnight apart during the migrating season, and aims at killing the mite when free from protection. The evidence as to its value seems conflicting. Some

growers have declared it to be of no use, while others have ascribed the removal of the disease in their plantations to its effect.

There appears no doubt, however, that it shows a tendency to burn the flowers and young leaves, and it cannot be prescribed as a specific. It also shares the weakness of all spray fluids, including soft soap and quassia mixtures, that it is impossible economically to apply it sufficiently often. In other words, while the migration is constant the action of the wash is only intermittent. Pearson has advocated spraying with quassia and soft soap; but according to his directions it is necessary to spray six times the first year and four times the second. The difficulty of this method is not so much the amount of wash required as the necessity of employing a lot of labour at a time of the year when growers find greatest difficulty in getting labour. It would seem, therefore, desirable to find some wash that with one application would so cover the bushes with a sticky substance that all migrating mites would be caught and killed. The success of such a wash would depend on the hypothesis that all new bud infestation is caused by migrating mites. Attempts have been made at Long Ashton to find such a wash, and one substance of some promise is already under trial.

A few bushes have been sprayed with a mixture of whiting and size with the idea of completely coating the big buds and thus preventing the egress of the mites. The attempt was unsuccessful, as the big buds swelled slightly and burst through their covering. It was interesting to notice, however, that the bushes sprayed with whiting and size showed a much sturdier growth, the leaves being not only slightly larger, but distinctly greener.

This effect will be further investigated this year.

Woolly Aphis.—Woolly Aphis or American Blight, is an old-established pest of the apple, but the amount of damage that it does depends on several factors. It is commonly present on old neglected apple trees, but it is most destructive on nursery stock. It attacks both stem and root, but it is on the former that its presence is most usually noted. In America it is the root form that does most damage, as its presence leads to various forms of root rot. This is not so common in England, but the colonies on the root serve as a breeding place from which in spring multitude of larvæ migrate up the stem. The root form, therefore, is of importance.

The nature of the soil appears to have considerable influence. Trees situated on medium or light lands often suffer severely, while those on heavy soils, like the lias clay at Evesham, are as a rule but lightly attacked.

The damage done is both direct and indirect. The punctures of the aphis induce excessive callus formation which not only deforms the tree and uses food materials uselessly, but which may serve as a harbouring place for other insects during the winter. But more

important than the direct damage is the indirect. It is practially certain that spores of the canker fungus find their way into the tree *via* the puncture holes of the aphis. The insects have indeed been found with the fungus spores adhering to their bodies, and it is easily possible for the insect to introduce the fungus spore in the act of puncturing the tree.

As to treatment it is clear that if the root form is present it is useless to attack the stem form only, since there is a migration of larvæ from the roots to the stem in the summer. To obtain success, therefore, it is necessary to attack both.

The stem form does not present great difficulties, though certain conditions are necessary for its extermination. The insect is covered by an abundant waxy covering so that a colony appears like a mass of cotton wool. This covering is an exceedingly effective protection against all ordinary liquids as it is impossible to wet it, and therefore impossible to kill the insects. It is only liquids of low surface tension that can wet the waxy covering, and of such probably the most effective is a paraffin emulsion. For easy wetting, however, both soft soap and paraffin must be present at a strength of at least 2 per cent. (2lbs. per 10 gallons). With this strength comparatively little force is necessary to penetrate completely the colonies and to kill them. Weaker strengths require much more force to break up the colonies, and are very likely to leave behind some unkilled specimens.

The root form is far more difficult to kill. The only remedy so far is to inject carbon disulphide. This liquid is injected at a depth of 4 to 6 inches at different points around a tree so as to saturate the soil round the tree with the poisonous vapour. It has the disadvantage that it sometimes injures the tree and that its action is very irregular, as much seems to depend on the dampness of the soil. Formaldehyde was tried at Long Ashton for treatment of the root form ; but though the results were encouraging the substance proved too expensive for extensive use.

This year an experiment has been laid out to test the lethal power of various substances. Carbon bisulphide injections, waterings with aqueous solutions of carbon bisulphide, toluene and potassium thiocarbonate will all be tried by themselves, and also combined with stem spraying.

Strawberry Moth.—This pest first appeared at Long Ashton in the summer of 1912, when its greyish larva did considerable damage. It reappeared in 1913, but the damage was less severe. The larva is found in the opening flower bud, where it eats round the receptacle, damaging the stamens, and ruining the flower for subsequent fruit production. It is not *Peronea comariana* hitherto recorded on strawberries, but a species not before found attacking them.

A BACTERIAL DISEASE OF FRUIT BLOSSOM.

By B. T. P. Barker and Otto Grove.

For several seasons the blossom of the pear trees in the plantations of this station at Long Ashton has been subject to more or less serious discoloration or blackening, which has led to the death of many of the flowers and the failure of many of the young fruits to develope. The loss of crop due to this trouble, while varying somewhat from year to year, has been in some seasons serious, certain varieties having failed to produce more than one or two odd fruits. Until last spring it was assumed that the damage was due to the injurious effect of frost, cold winds, and other unfavourable weather conditions on the blossom. Last season, however, Mr. J. W. Eves, at that time Pomologist at the Station, watched the outbreak, which was a very serious one, very closely during the blossoming period, and came to the conclusion that the symptoms strongly suggested that the attack was caused by a parasitic organism. At his request a microscopical examination of the diseased tissues of affected flowers was made, and it was soon ascertained that they were crowded with bacteria. Plate cultures of malt extract gelatine were made in order to isolate the organisms present: and in the course of a few days numerous colonies of bacteria developed. Only one kind of organism proved to be present, and this was quickly obtained in pure culture. Infection experiments on healthy undamaged pear flowers were then made, the tissues being infected with the organism in some cases by fine needle punctures and in other cases simply by superficial contact without injury. In nearly all instances the characteristic discoloration of the blossom followed a few days after infection, both when the inoculations were made with and without injury: while control flowers which were punctured with a needle but not infected with the bacterium remained perfectly healthy as a rule. A few of the latter flowers blackened in the same way as the infected blossoms, but this was found in due course to be due to natural infection, the bacterium being so widely distributed that few flowers were altogether free from it.

Having thus demonstrated that the disease was due to the

action of the bacterium a detailed study of it was begun. The following account summarises the results obtained last year, and a fuller description is being published in the *Annals of Economic Biology*, Vol. I., No. 1. The investigation is still in progress, fuller information as to the natural mode of infection and methods of treatment being required.

The disease occurs most commonly in one or other of the two following forms.

In the one case the sepals first show signs of the disease, their tips turning grey and beginning to blacken. Under suitable weather conditions the blackening gradually extends over the whole calyx and downwards along the flower stalk, death of the flower quickly resulting. Young, unopened buds are commonly affected in this way. In moist weather they soon fall from the blossom truss : but under drier conditions they remain attacked in a shrivelled, mummified and blackened state. Frequently in these cases the disease spreads downwards into the tissues of the fruit spur, which soon presents the appearance of a barren stump owing to the falling off of the flowers and leaves. The bacteria do not apparently cause serious internal injury to the tissues of the spur the parts infected being limited to a few fine strands of cells. The organisms sometimes penetrate downwards into the spur for about an inch, and have been found to live in the spur tissues in an active condition throughout the winter. There seems little doubt that fresh infection can and does take place in the following spring from such affected spurs. The variety Catillac is very susceptible to the disease in this form, and many of the trees at the Station are covered with barren spurs produced by the disease.

In its other commonly occurring form the disease is first seen as small blackish dots on the receptacle of the flower. These dots increase in size and frequently coalesce, so that the whole surface of the disc is discoloured. Infection spreads thence to the ovary of the flower, and death follows in due course.

Occasionally the stigma and style of the pistil of the flower are attacked first. Sometimes the attack occurs on the petals, small black areas being formed on them.

The weather conditions appear to have considerable influence upon the intensity of the disease. In cold, damp weather it spreads rapidly and proceeds far enough to kill the flower. In warm, dry weather fewer flowers are attacked, and the affected areas of the tissues of infected flowers may not increase seriously in size. The young fruit may in such cases develope sufficiently quickly to throw off the disease.

Under suitable conditions the disease spreads rapidly from flower to flower. It has been proved that bees play an active part in distributing it.

Occasionally the leaves as well as the flowers are attacked, the disease appearing on them in the form of small blackened areas which eventually dry up and fall away.

The infection of fruit spurs has already been referred to. It is probable that this seat of the disease is even more important than that on the flowers, since the bacillus winters in the tissues of the spur and infection spreads thence the following spring. This complication renders the treatment of the disease very difficult, if not impossible, since spraying cannot reach the affected tissues and the drastic treatment of pruning off all affected parts of the tree would necessitate the removal of a large proportion of the spurs and, therefore, the sacrifice of most of the crop.

An examination of the flowers of several other plants has shown in some cases somewhat similar damage in a lesser degree. The bacterium has already been isolated from apple, plum, and cherry flowers. Whether or not it is responsible for serious disease of these plants is at present uncertain. There is no question that the organism is very widely spread, and it may occur on plants other than pears without causing disease. It has also been found in the soil under fruit trees, and may be distributed each year from that habitat.

Many specimens of diseased blossom were sent from different parts of the country last spring for examination. In a large number of instances the bacterium was found to be present and to cause the disease. The organism is, therefore, undoubtedly widely distributed and probably is the cause of numerous attacks throughout the country. It has been found on pear blossom sent from Devon, Middlesex, Worcestershire, Gloucestershire, Herefordshire, and Warwickshire, and on apple blossom sent from Gloucestershire, Herefordshire, Essex, and Sussex.

It has already been mentioned that infection experiments with the bacterium have been successfully carried out with pear blossom. The varieties mainly used were Catillac, Beurré d'Amanlis, Louise Bonne de Jersey, and Vicar of Winkfield, all of which are readily attacked. Under natural conditions the two former varieties appear to be specially susceptible.

Inoculations of the bacillus were also made on young shoots of apples, pears, plums, and gooseberries, by means of needle punctures. Although the bacillus continued to live and to multiply to some extent at the points of inoculation, it caused no serious injury to the surrounding tissues. A few infections on fruits of Catillac pears, when they had nearly reached maximum size, were also similarly made, but no serious results followed.

With regard to the characters of the organism itself it grows readily on various nutrient gelatine media, rapidly causing liquifaction of the gelatine. Malt extract gelatine constitutes one of the best media for ordinary use. On most media the organism retains

its activity for several weeks and preserves its parasitic powers. In due course, however, on most of the media tested it eventually dies off. Streak cultures on potato blocks retain their vitality for a much longer period, and inoculations have been successfully made with material from these cultures over eight months old.

The bacillus is a short rod about 2–4 μ x ·5–·8 μ in size. The cells are actively motile, having two or more flagellæ at least 4–5 times as long as the cells themselves at one pole of the cell. The motility of the cells is largely determined by conditions of aeration, the cells losing their movement quickly when oxygen is lacking. The organism stains well with the usual stains, and is also coloured by Gram's method.

The cells usually occur singly, or in pairs, rarely in long chains. Involution forms are produced very readily. No endospores have yet been observed. The organism possesses strongly developed peptonising properties, as indicated by the rapid liquefaction of gelatine, accompanied by the production of ammonia. The colour of the colonies on various media is whitish or cream. Old cultures in glucose peptone solution show a pronounced greenish fluorescence, which has not been seen in the case of any other media. No fermentation occurs in solutions of various sugars, and no indol reaction has been found.

The characters of the organisms are more fully described in the paper referred to above. From them the organism appears to be a species of Pseudomonas which so far has not been identified with any other form previously described. On account of its wide distribution and occurrence in the soil it is possible that it may be known to soil bacteriologists as one of the ammonia forming types.

THE APPLE CANKER FUNGUS.

By S. P. Wiltshire.

Some research has been attempted into the life history of the Apple Canker Fungus, *Nectria ditissima*, since this disease is of great economic importance to fruit growers.

An account of the work so far as it had proceeded at the time was given in a paper read before the Botanical Section of the British Association, at Birmingham, in September, 1913. The following is an abstract of that paper:—

The fungus enters the tree only through wounds in the stem and produces in time the characteristic cankered appearance of the branch. Wounds through which infection can take place must reach almost to the wood; otherwise a bark layer is formed round the inoculated portion, which is thus excluded, and the tree heals itself of the attack. If, however, the wound is sufficiently deep to allow the fungus to reach the wood, then infection always takes place. Hence we find in nature that the wounds which permit of infection are chiefly those caused by frost and by the woolly aphis, in both these cases the wood becoming exposed.

The formation of a new bark layer at the limits of the infected portion of the cortical region successfully confines the extent of the fungus in the cortex; hence the fungus lives in the wood rather than in the bark. Some attempt is made by the woody zone to prevent the spread of the fungus by the secretion of wound gum, thus blocking up the cavities through which the fungus travels, but since the wound gum can finally be penetrated the reaction is only partially successful.

The swelling which is frequently exhibited at a cankered spot is due to the rapid formation of an abnormal kind of wood, possibly to compensate for that portion of the wood which has been killed by the disease.

The question whether the fungus travels about the stem and causes the formation of cankers without external inoculation has not yet been satisfactorily decided; but usually the fungus is extremely local, and, at any rate, there is no foundation for the view that it lurks in apparently healthy tissue. It is quite safe to use shoots from any tree for grafting purposes provided that the cut surface of the stem appears quite healthy.

The investigation is still incomplete and is being continued. The question of the factors determining the degree of susceptibility of a variety to the disease is receiving special attention, and experiments are in progress with the object of ascertaining, if possible, what factors are concerned and their methods of influence. The question of soil influence is also under investigation.

CROP RECORDS FROM THE VARIETY TRIALS OF FRUITS.

The accompanying table gives statistics of the yields of fruit of individual varieties grown in the plantations at the Institute. The trees in Plantation No. I., in the case of apples are one year older than those in Plantation No. II., and in the case of pears two and three years older. Too much regard should not be given to these figures as representative of the capability of the varieties in question at the Institute, since they have not been grown with the sole idea of obtaining the maximum crop possible. Various experiments have been made with the trees, and the yield in many instances has suffered on that account. Since, however, the same kind of treatment has been generally uniform for different varieties the results for individual varieties are comparable.

In the case of gooseberries and red and white currants in Plantation No. I., and of raspberries in Plantation No. II., the plants last spring had to be removed on account of the increasing size of the apple and pear trees between which they were planted. The trials so far as those varieties were concerned have now been completed. The total figures from 1907–1912 are given in this table to show the final result of the trials. It will be observed that Keepsake and Whinham's Industry among the gooseberries, Raby Castle of the red currants, and Lord Beaconsfield, Red Antwerp and Semper Fidelis (Strain A) are decidedly ahead of the other varieties included in the trials.

Name of Variety.	Yield in lbs.	
	1913.	1906-12.
PLANTATION No. I.		
APPLES DESSERT—		
Allington Pippin 27 bushes and 3 standards ..	202¼	790
Beauty of Bath .. „	—	57¾
Cox's Orange Pippin „	39¼	317¼
Devonshire Quarrenden „	13	220¾
King of the Pippins „	5¼	743¼
Worcester Pearmain „	39½	382½

Name of Variety.		Yield in lbs. 1913.	Yield in lbs. 1907-12.
PLANTATION No. I.—*continued.*			
APPLES. CULINARY—			
Stirling Castle	27 bushes and 3 standards ..	15½	397¼
Newton Wonder ..	„	328¾	488¼
Lane's Prince Albert	„	123½	536½
Bramley's Seedling	„	241¾	409¼
Lord Suffield ..	„	3½	171½
Ecklinville ..	„	6½	566½
PEARS—			
Catillac	„	167¾	324½
Doyenné Boussoch ..	„	25¼	360¾
Louise Bonne de Jersey	„	23¾	231½
Williams' Bon Chrêtien	„	25¾	219¾
GOOSEBERRIES—			
Crown Bob	90 plants	PLANTS REMOVED 1912.	1056¾
Keepsake ..	„		2467¾
Lancashire Lad ..	„		1623
Whinham's Industry	„		2845½
RED CURRANTS—			
Fay's Prolific ..	90 plants		794¾
Knight's Sweet Red	„		743¾
Raby Castle ..	„		1411½
WHITE CURRANTS—			
White Dutch ..	90 plants		990½
PLANTATION No. II.			
APPLES—			
Bismarck ..	7 bushes and 3 standards ..	29½	412¼
American Mother ..	„	7½	25¼
King's Acre Pippin ..	„	94¼	173¼
Lady Sudeley ..	„	42	42¼
Lord Grosvenor ..	„	302¼	269½
Warner's King ..	„	193	316
White Transparent ..	„	36¾	130¾
Gascoyne's Scarlet Seedling	„	113¼	137¼
Court Pendu Plât	10 bushes	73¾	78¼
Frogmore Prolific ..	„	80	207¾
James Grieve ..	„	60½	322½
Lord Derby ..	„	157½	315
Peasgood's Nonsuch ..	„	64¾	98¾
Potts' Seedling ..	„	169¼	164¾
Rival	„	34¼	152½
Sturmer Pippin ..	„	142	251¾

Name of Variety.	Yield in lbs. 1913.	1907-12.
PLANTATION No. II.—*continued.*		
APPLES—*continued.*		
Wealthy .. 7 bushes and 3 standards ..	12	75¼
Coronation .. .. „	—	48¾
Golden Noble .. „	—	22
Lord Hindlip .. „	11½	34¼
Royal Jubilee .. „	21	152⅜
Charles Ross .. „	163½	83¼
Wellington .. „	15	203½
The Houblon .. „	—	35
PEARS—		
Conference .. 7 bushes and 3 standards ..	14	169¼
Dr. Jules Guyot .. „	31¼	155¼
Hessle .. .. „	½	123½
Pitmaston Duchess .. „	17½	46½
Bellissime d'Hiver 10 bushes	21	95
Durondeau .. .. „	11	3
Emile d'Heyst .. „	15	65½
Vicar of Winkfield .. „	7¾	18
Petite Marguerite .. „	4	45
Beurré Hardy .. „	—	6
Beurré d'Amanlis .. „	—	25¾
Triomphe de Vienne „	—	5
PLUMS—		
Denniston's Superb 7 bushes and 3 standards ..	5¾	18
Pond's Seedling .. „	109¾	179¼
Early Transparent Gage „	46	66¼
Belle de Louvain 7 bushels and 3 standards ..	7	28½
Monarch .. 10 bushes	6	7½
Heron .. .. „	—	17¾
Early Rivers .. „	—	30
Czar .. .. „	13	34
Mallard .. .. „	—	6½
Late Orange .. „	½	12
Victoria .. .. „	½	58¼
BLACK CURRANTS—		
Boskoop Giant 30 plants	8	106¾
Black Prince .. „	5	75
Goliath .. .. „	1½	57
Ogden's Black .. „	29	187
Victoria .. .. „	5	68
RED CURRANTS—		
Cherry .. 30 plants	15	40¾
Comet .. .. „	—	22½
La Fertile .. .. „	—	32½
La Hâtive .. .. „	—	32½

Name of Variety.	Yield in lbs. 1913.	1907-12.
PLANTATION No. II.—*continued.*		
RED CURRANTS—*continued.*		
La Versailles 30 plants	23	53½
New Red Dutch .. „	147¼	205¾
Red American .. „	69	44¾
Red Grape .. „	30½	29¾
Moore's Seedling .. „	40½	15
La Transparent .. „	5½	54½
Red Cross .. .. „	—	27½
WHITE CURRANTS—		
White Dutch Cut Leaf 30 plants	—	56¾
White Transparent „	33	64¼
White Versailles .. „	6	59½
RASPBERRIES—		
Abundance 150 plants	PLANTS REMOVED 1912.	318¼
Baumforth's Seedling „		260
Carter's Prolific .. „		206½
Red Antwerp .. „		409½
Semper Fidelis (*a*) .. „		390¾
„ „ (*b*) .. „		261¼
Lord Beaconsfield .. „		443½
GOOSEBERRIES—		
Blucher .. 20 bushes	54½	68¼
Careless .. .. „	44	267¾
Early Sulphur .. „	36½	211¾
Faithful .. .. „	22	245¾
Falstaff .. .. „	37	213¼
Fascination .. „	11¾	263½
King of Trumps .. „	82½	520
Leader.. .. .. „	45½	263
Leveller .. .. „	10½	18¼
May Duke .. .. „	—	271½
Mount Pleasant .. „	30¼	114½
Red Warrington .. „	84	254
Surprise .. .. „	22¼	313
Telegraph .. .. „	36½	421¾
Golden Gem 10 bushes	15	68¼
Gretna Green .. „	40	232
Dan's Mistake .. „	31¼	41½
Diadem .. .. „	—	187¼
High Sheriff .. „	8½	56¼
Hero of the Nile .. „	11½	42¾
Langley Gage .. „	33⅓	238
Ringer .. .. „	5¾	57
Thatcher .. .. „	—	88¾
Victoria .. .. „	41½	138¾
Red Champagne .. „	23	106¼
Transparent .. „	—	118

THE TIME OF BLOSSOMING OF FRUIT TREES.

Since the year 1908 records have been kept of the flowering periods of the varieties of fruit trees grown in plantations and orchards at the Institute. These have been published regularly in the Annual Reports of the National Fruit and Cider Institute, and particulars of interest relating to the records were discussed in the Report for 1912.

There is no occasion here to recapitulate those details, nor during the past year have any fresh points of interest come to light. Attention may be called particularly to the records for vintage apples on the Free and Paradise Stocks respectively. Although in the majority of cases where the same variety occurs on the two types of root stock, the dates of blossoming do not quite coincide, nevertheless there is generally little difference between the dates in the two cases. It may therefore be concluded that at any rate as far as time of blossoming is concerned the question of root stock influence is not important.

Mention may be made of similar records which are being kept at other experiment stations concerned with fruit work in this country. Among these may be mentioned the records of Mr. F. J. Chittenden at the Royal Horticultural Gardens at Wisley, and of Mr. Spencer Pickering at the Woburn Experimental Fruit Farm. The particulars now available from these and other stations in various parts of the country make it possible to draw up conclusions as to the approximate order of flowering for individual varieties, and such information is likely to be of great service in connection with the problems of cross-pollination of fruit trees.

Variety.	Date of Flowering.					
	1913	1912	1911	1910	1909	1908
APPLES. (Market Varieties).						
Beauty of Bath	Apl. 18	Apl, 20	May 5	May 4	May 7	May 6
Devonshire Quarrenden ..	„ 19	„ 20	„ 7	„ 1	„ 6	„ 5
White Transparent.. ..	„ 20	„ 20	„ 5	„ 2	„ 7	„ 11
Sturmer Pippin	„ 22	„ 22	„ 8	„ 4	„ 5	„ 9
Warner's King	„ 22	„ 20	„ 5	Apl. 30	„ 5	

Variety.	Date of Flowering.					
	1913	1912	1911	1910	1909	1908
APPLES.						
(Market Varieties—*continued*)						
Bismarck	Apl. 23	Apl. 20	May 4	May 2	May 7	
Allington Pippin	,, 28	,, 22	,, 8	,, 12	,, 7	
Blenheim Orange	,, 28	,, 29	,, 8	,, 12	,, 7	
Charles Ross	,, 28	,, 24	,, 8	,, 7	,, 7	
Cox's Orange Pippin	,, 28	,, 27	,, 9	,, 9	,, 9	May 11
Ecklinville	,, 28	,, 19	,, 8	,, 4	,, 7	,, 11
Stirling Castle	,, 28	,, 15	,, 7	Apl. 29	,, 6	,, 5
Wealthy	,, 28	,, 22	,, 8	May 1	,, 9	,, 12
King of the Pippins	,, 30	,, 21	,, 8	,, 8	,, 6	,, 12
Lord Grosvenor	May 1	,, 25	,, 9	,, 4	,, 9	
Lord Suffield	,, 1	,, 13	,, 8	Apl. 29	,, 9	,, 10
Pott's Seedling	,, 1	,, 25	,, 9	May 5	,, 10	
The Queen	,, 2	,, 24				
James Grieve	,, 3	,, 20	,, 6	,, 6	,, 5	,, 13
Lord Derby	,, 3	,, 25	,, 10	,, 12	,, 10	
King's Acre Pippin	,, 3	,, 22	,, 9	,, 8	,, 7	
Lord Hindlip	,, 5	,, 20	,, 6	,, 7	,, 8	
Worcester Pearmain	,, 6	,, 22	,, 7	,, 4	,, 7	,, 11
Rival	,, 6	,, 22	,, 10	,, 7	,, 11	
Bramley's Seedling	,, 7	,, 19	,, 7	,, 10	,, 5	,, 1
Coronation	,, 7	,, 25	,, 15	,, 19	,, 14	
Frogmore Prolific	,, 7	,, 24	,, 9	,, 8	,, 9	
Houblon	,, 7	,, 25	,, 10	,, 13	,, 8	
Peasgood's Nonsuch	,, 7	,, 21	,, 8	,, 3	,, 10	
Wellington	,, 7	,, 24	,, 10	,, 14	,, 10	
Lady Sudeley	,, 9	,, 28	,, 9	,, 18	,, 9	,, 14
Annie Elizabeth	,, 9	May 3				
Newton Wonder	,, 10	Apl. 24	,, 8	,, 9	,, 9	
Lane's Prince Albert	,, 11	,, 15	,, 10	,, 8	,, 11	,, 11
Gascoyne's Scarlet Seedling	,, 13	,, 25		,, 12	,, 11	
Golden Noble	,, 13	,, 29	,, 10	,, 17	,, 14	
American Mother	,, 16	,, 29	,, 10	,, 21	,, 9	
Royal Jubilee	,, 18	May 1	,, 14	,, 18	,, 14	,, 27
Court Pendu Plat	,, 24	,, 9	,, 15	,, 24	,, 14	
Dartmouth Crab		Apl. 22	,, 8	,, 8		
Keswick Codling		,, 19	,, 8	Apl. 29		
Siberian Crab		,, 15	,, 5	,, 24		
APPLES (on the Paradise Stock).						
Vintage Varieties :—						
Jarrow Bank	Apl. 21			May 3	May 9	
Pride of Australia	,, 24	May 4			,, 8	
Winesour	,, 25	,, 3				
White Bache	May 1	Apl. 30	May 12		,, 11	
Dymock Red	,, 5		,, 11	,, 14	,, 9	May 22
Cap of Liberty	,, 7	,, 27	,, 13		,, 8	
Fréquin Rouge	,, 7		,, 11	,, 4	,, 8	
Victoria	,, 7	,, 28	,, 11		,, 9	
Eggleton Styre	,, 7	,, 29			,, 9	

Variety.	Date of Flowering.					
	1913	1912	1911	1910	1909	1908
APPLES (on the Paradise Stock)—*continued.*						
Vintage Varieties :—						
Cherry Pearmain	May 8	May 5		May 10	May 9	
Maggs' Seedling	,, 10	,, 3	May 12		,, 9	
Red Manse	,, 10		,, 13			
Roussie	,, 10	,, 4	,, 12		,, 10	
Ecarlatine	,, 10	Apl. 29			,, 8	
Bramley's Seedling	,, 10					
Crémière	,, 11	,, 29	,, 10		,, 12	
Cummy Norman	,, 11		,, 11		,, 11	
No. 42	,, 12		,, 12		,, 10	
Reinette Obry	,, 12	May 1	,, 12		,, 9	
Taylor's Spie	,, 12	,, 4			,, 12	
No. 61	,, 12				,, 10	
Kingston Seymour	,, 12				,, 11	
Bramtot	,, 13	Apl. 30	,, 10		,, 11	
Cowarne Red	,, 13		,, 11	,, 16	,, 11	May 19
Kingston Black	,, 13	,, 30	,, 17		,, 11	
Kingston Black Improved	,, 13	,, 30	,, 12	,, 17	,, 11	
Red Streak	,, 13		,, 13	,, 17	,, 9	,, 19
Red Streak (Somerset)	,, 13		,, 12			
Silver Cup	,, 13		,, 12		,, 11	
Sweet Alford	,, 13	May 6	,, 11	,, 13	,, 11	
Woodbine	,, 13		,, 15			
Neverblight	,, 13	Apl. 30		,, 15	,, 11	
Sweet Coppin	,, 13	,, 30			,, 11	
Chiffers	,, 13				,, 10	
William Anderson	,, 13				,, 11	
Bealy Down Pippin	,, 14	Apl. 28			,, 8	
Médaille d'Or	,, 15		,, 17	,, 22	,, 18	,, 31
Sharpe's Summer	,, 15				,, 10	
Dabinett	,, 16	May 6	,, 16	,, 15	,, 13	,, 22
Fréquin Audièvre	,, 16		,, 13	,, 23	,, 17	
Major	,, 16	,, 2	,, 12	,, 20	,, 13	
Phillip Norman	,, 16		,, 18		,, 13	
Rouge de Trèves	,, 16	,, 4	,, 12		,, 9	
Fair Maid of Devon	,, 16	,, 1			,, 10	
Doux Amer	,, 17	Apl. 30	,, 12		,, 10	
Footlands No. 2	,, 17	,, 30	,, 16		,, 11	
Knotted Kernel	,, 17	,, 29	,, 12		,, 13	
Red Foxwhelp	,, 17		,, 16		,, 11	
Thomas Hunt	,, 17	May 4	,, 11	,, 17	,, 11	
White Norman	,, 17	Apl. 28	,, 12		,, 13	
Woolston Spice	,, 17		,, 16		,, 11	
Yarlington Mill	,, 17		,, 16	,, 17	,, 13	,, 19
The Bell	,, 17	,, 27			,, 13	
Skyrme's Kernel	,, 17				,, 10	
Glory of the West	,, 17				,, 10	
Northwood	,, 17				,, 11	
White Styre	,, 17				,, 11	
Sweet Bay	,, 17					
Chevalier	,, 18		,, 14	,, 16	,, 17	
M. Jacques No. 1	,, 18	May 6			,, 8	
King	,, 18				,, 10	
Yeovil Sour	,, 18				,, 13	

Variety.	Date of Flowering.					
	1913	1912	1911	1910	1909	1908
APPLES (on the Paradise Stock)—*continued*						
Vintage Varieties :—						
Hartisman	May 18					
Royal Jersey (Crofts)	„ 19		May 12		May 17	
White Jersey	„ 19		„ 13	May 20	„ 15	May 22
Argile Grise	„ 21	May 6			„ 9	
White Close Pippin	„ 21				„ 9	
Royal Wilding	„ 22		„ 13	„ 19	„ 13	
Dove	„ 22	„ 4		„ 23	„ 9	
Pytheres	„ 22	Apl. 30			„ 13	
Court Royal	„ 22				„ 9	
No. 32	„ 22				„ 9	
Harry Masters	„ 22				„ 18	
Brown Jersey	„ 23		„ 11		„ 15	
Dove Seedling	„ 23				„ 10	
Virgin Mary	„ 23					
Horners	„ 23					
Bèdans des Partes	„ 26		„ 17		„ 13	
Bedminster	„ 26				„ 18	
Broadleaf Norman	„ 27	„ 29			„ 13	
Cherry Norman	„ 27				„ 10	
Strawberry Norman	„ 28		„ 17		„ 18	
M. Jacques, No. 2	„ 28	May 2			„ 13	
Vignons	„ 28				„ 10	
Amie de Berthivise	„ 28				„ 9	
Sandford Jersey	„ 28	„ 7	„ 13		„ 13	
Royal Jersey	„ 31	„ 7	„ 14	„ 22	„ 11	„ 6
Improved Pound		Apl. 29	„ 12		„ 10	
M. Jacques		„ 27	„ 11	„ 2	„ 8	„ 11
Osborn's Cadbury			„ 16			
Tardive Forestier		„ 28	„ 13		„ 8	
Umbrella			„ 18		„ 10	
Broadleaf Jersey					„ 9	
Hardwicke		„ 28			„ 9	
Porter's Perfection		May 1				
Davis Crab					„ 8	
Rouge Bruyère		Apl. 26			„ 9	
Smyth Osbourne No. 7		May 5				
Little Mother					„ 10	
Chisel Jersey					„ 11	
APPLES (on the Free Stock).						
Pride of Australia	Apl. 21		„ 9		„ 8	
Fertile de Caen	„ 25	Apl. 19				
Tardive Forestier	May 1	„ 21				
Early Cider Pearmain	„ 2	„ 29				
Eggleton Styre	„ 3	„ 21	„ 9	„ 5	„ 11	„ 15
Cap of Liberty	„ 5	„ 23	„ 7	„ 9	„ 11	„ 14
Dymock Red	„ 5	May 4	„ 9	„ 9	„ 11	„ 24
Stubbard	„ 6	Apl. 22				
Cherry Pearmain	„ 7	„ 28	„ 12	„ 11		

Variety.	Date of Flowering.					
	1913	1912	1911	1910	1909	1908
APPLES (on the Free Stock)—*continued.*						
Court Royal	May 7	Apl. 23	May 8	May 6	May 11	May 12
Knotted Kernel	,, 8	,, 23	,, 9	,, 5	,, 13	,, 16
Ecarlatine	,, 10	,, 18	,, 10	,, 9	,, 12	
Crémière	,, 12	,, 24	,, 12	,, 12	,, 12	,, 21
Chisel Jersey	,, 14	May 3	,, 9	,, 9	,, 11	,, 17
Kingston Black	,, 14	,, 2	,, 12	,, 12	,, 13	,, 24
Reinette Obry	,, 14	Apl. 24	,, 13	,, 14	,, 17	,, 20
Never Blight	,, 14	May 3				
Cowarne Red	,, 15	,, 4	,, 13	,, 14	,, 17	,, 21
Dabinett	,, 15	,, 5	,, 12	,, 14	,, 17	,, 22
Doux Amer	,, 15	,, 6	,, 12	,, 17	,, 12	,, 22
Foxwhelp	,, 15		,, 11	,, 9		
Sweet Alford	,, 15	,, 4	,, 12	,, 14	,, 19	,, 22
Broadleaf Jersey	,, 16	,, 6	,, 17		,, 14	,, 23
Maggs's Seedling	,, 16	Apl. 25	,, 10		,, 11	,, 22
Royal Jersey	,, 18	May 4	,, 13	,, 19	,, 23	
Bèdans des Partes	,, 21	,, 4	,, 20	,, 17	,, 12	,, 31
Rouge de Trèves	,, 21	Apl. 24				
Skyrme's Kernel	,, 23	,, 30	,, 13	,, 15	,, 19	,, 22
Cherry Norman	,, 24	,, 30				
Black Norman	,, 24	May 4				
Strawberry Norman	,, 26	,, 4	,, 19	,, 21	,, 19	,, 8
Harry Masters	,, 26	,, 6	,, 17	,, 20	,, 22	,, 18
Médaille d'Or	,, 29	,, 30	,, 18	,, 10	,, 20	,, 31
Wesleyan	June 9					
Jones Seedling		Apl. 21	,, 9	,, 8	,, 10	,, 18
M. Jacques No. 2			,, 7	,, 5	,, 10	
Sharp's Midsummer		,, 25	,, 12	,, 9		,, 23
Stuart's Seedling		,, 22	,, 11	,, 9	,, 11	,, 26
White Jersey		May 5	,, 14	,, 17	,, 23	,, 25
Yarlington Mill		Apr. 25	,, 15	,, 14		
Bramtot		,, 25				
Broadleaf Norman		May 5				
Butleigh No. 14		Apl. 21				
Major		May 7				
Oakham Green		Apl. 30				
Royal Jersey (Butleigh)		,, 28				
Sandford Jersey		May 7				
Sweet Coppin		,, 6				
White Alphington		,, 5				
PEARS.						
Market Varieties :—						
Beurré d'Amanlis	Mar. 16	Mar. 29	Apl. 21	Apl. 13	Apl. 28	,, 1
Beurré Clairgeau	,, 25					
Louise Bonne de Jersey	,, 29	,, 25	,, 13	,, 3		
Doyenné Boussoch	,, 30	Apl. 6	,, 22	,, 13	,, 24	Apl. 28
Conference	,, 31	,, 2	,, 20	,, 15	May 1	
Vicar of Winkfield	,, 31	,, 1	,, 21	,, 13		
Dr. Jules Guyot	,, 31	,, 13	,, 26	,, 18	,, 3	May 3
Catillac	,, 31	,, 8	,, 29	,, 22	,, 3	,, 3

Variety.	Date of Flowering.					
	1913	1912	1911	1910	1909	1908
PEARS.						
Market Varieties—*continued.*						
Durondeau	Apl. 2	Apl. 1	Apl. 27	Apl. 24	Apl. 26	May 1
Emile d'Heyst	,, 4	,, 9	,, 19	,, 15	,, 28	,, 1
Bellissime d'Hiver	,, 4	,, 2	,, 29	,, 13	,, 26	,, 1
Petite Marguerite	,, 9	,, 6	,, 25	,, 23	May 1	
Williams' Bon Chrétien	,, 10	,, 9	,, 21	,, 14	Apl. 28	Apl. 30
Pitmaston Duchess	,, 12	,, 13	,, 28	,, 21	May 3	May 3
Triomphe de Vienne	,, 12	,, 13		,, 25	,, 4	
Hessle	,, 13	,, 10	,, 29	,, 21	,, 3	
Beurré Hardy	,, 18	,, 9				
Vintage Varieties :—						
Taynton Squash	Apl. 14	,, 8	May 4	,, 30	Apl. 30	,, 3
Barnet	,, 14					
Moorcroft	,, 21	,, 7	,, 3	May 1	,, 30	,, 3
Oldfield	,, 21	,, 13	,, 3	,, 1	May 5	,, 3
Blakeney Red	,, 21					
Barland	,, 25	,, 18	,, 4	Apl. 30		
J. Amphlett	,, 26	,, 15				
PLUMS.						
Mallard	Mar. 7	Mar. 20	Apl. 3	Apl. 10	Apl. 17	Apl. 19
Monarch	,, 18	,, 22	,, 14	,, 15	,, 17	,, 30
Jefferson	,, 29	,, 22	,, 14		,, 17	
Heron	,, 29	,, 24	,, 17	,, 15	,, 18	,, 30
Late Orange	,, 29	,, 23	,, 19	,, 25	,, 19	
Early Prolific	Apl. 1	,, 27	,, 18	,, 20	,, 22	,, 29
Denniston's Superb	,, 1	,, 25	,, 19	,, 20	,, 20	,, 30
President	,, 1	,, 26	,, 20	,, 23	,, 28	May 1
Early Transparent Gage	,, 2	,, 26	,, 19	,, 20	,, 22	Apl. 30
Victoria	,, 2	,, 29	,, 19	,, 19	,, 22	May 1
Goliath	,, 2	,, 31	,, 25			
July Green Gage	,, 2					
Pond's Seedling	,, 3	,, 31	,, 23	,, 27	,, 26	
Czar	,, 4	,, 30	,, 21	,, 17	,, 23	Apl. 30
Belle de Louvain	,, 4	,, 28	,, 24		,, 26	
Comte d'Althann's Gage	,, 5			,, 23	,, 28	
Kirke's	,, 18	Apl. 3			,, 26	
RASPBERRIES.						
Superlative	May 22	May 4				
Hornet	,, 22	,, 12				
Northumberland Fillbasket	,, 24	,, 5				
Norwich Wonder	,, 24	,, 9				
Abundance		,, 1	May 25	May 25	May 28	
Lord Beaconsfield		,, 4	,, 26	,, 25	,, 26	
Semper Fidelis		,, 5	,, 27	,, 25	,, 28	
Red Antwerp		,, 7	,, 24	,, 25	,, 28	
Carter's Prolific		,, 9	,, 31		,, 27	
Baumforth's Seedling		,, 11	,, 26	,, 24		

Variety.	Date of Flowering.				
	1913	1912	1911	1910	1909
STRAWBERRIES.					
Keens' Seedling	May 7	May 5	May 11	May 9	May 11
Auguste Nicaise	,, 7	Apl. 28	,, 11	,, 9	,, 11
Leader	,, 8	,, 22	,, 10	,, 10	,, 14
President Loubet	,, 8	May 7	,, 18	,, 23	,, 20
Trafalgar	,, 8	,, 5	,, 17	,, 20	,, 17
Queen Denmark	,, 13	,, 3	,, 12	,, 16	,, 14
Royal Sovereign	,, 14	Apl. 30	,, 9	,, 14	,, 12
La Grosse Sucrée	,, 14	May 5		,, 9	,, 11
Louis Gauthier	,, 15	Apl. 28	,, 11	,, 18	,, 9
St. Antoine de Padoue	,, 15	May 3	,, 11	,, 9	,, 12
Dr. Hogg	,, 15	,, 4	,, 16	,, 15	,, 14
Sir Joseph Paxton	,, 15	,, 5			,, 17
Unique	,, 15				
Reliance	,, 15				
St. Joseph	,, 16	,, 5	,, 12	,, 13	,, 11
Sir Charles Napier	,, 17	Apl. 22	,, 10	,, 13	,, 11
The Bedford	,, 17	,, 27			
Scarlet Queen	,, 17	,, 28	,, 10	,, 16	,, 13
Connoisseur	,, 17	,, 28			
British Queen	,, 17	May 5	,, 17	,, 16	,, 17
Fillbasket (Laxton's)	,, 17	,, 5	,, 15		,, 21
Elton Pine	,, 17	,, 6	,, 16		,, 23
Bedford Champion	,, 18				,, 13
Reward	,, 18	Apl. 28			,, 13
Cropper	,, 18	,, 28			
Progress	,, 18	,, 29			
New Pine	,, 18				
Profit	,, 20	,, 27			
New Pine Apple	,, 20	,, 27			
Givon's Late Prolific	,, 22				,, 21
Utility	,, 24				
New Epicure	,, 26				
Latest 1904	,, 28				
STRAWBERRIES. (Planted 1913)					
Empress of India	May 17				
King of the Earlies	,, 17				
Tuckswood Early	,, 17				
Gunton Park	,, 17				
Dr. Morère	,, 17				
Vicomtesse H. de Thury	,, 17				
Kentish Favourite	,, 17				
The Laxton	,, 19				
George Monro	,, 19				
The Queen	,, 26				
King George	,, 26				
The Earl	,, 27				
Main Crop	,, 27				

Variety.	Date of Flowering.				
	1913	1912	1911	1910	1909
STRAWBERRIES. (Planted in 1913)—*continued.*					
Royal Soveriegn :—					
Backhouse	May 14				
Bunyard	„ 16				
Clarke	„ 16				
King's Acre	„ 17				
Merryweather	„ 17				
Hillier	„ 17				
Pyne	„ 18				
Barbier	„ 18				
Wiseman	„ 19				
Le Cornu	„ 19				
Drummond	„ 20				
Daniels	„ 20				
BLACK CURRANTS.					
Black Prince	Apl. 27	Apl. 20	Apl. 26	Apl. 24	Apl. 27
Victoria	„ 28	„ 20	„ 26	„ 28	„ 29
Ogden's Black	„ 28	„ 22	„ 30	„ 24	„ 30
Boskoop Giant	„ 29	„ 20	„ 27	„ 27	„ 30
Goliath	„ 29	„ 22	„ 24	„ 24	„ 29
GOOSEBERRIES.					
Langley Gage	Mar. 31	Mar. 21	Mar. 27		
Keepsake	„ 31	„ 22	„ 27		
King of Trumps	„ 31	„ 22	„ 30		
Whinham's Industry ..	„ 31	„ 22	Apl. 2		
Crown Bob	„ 31	„ 22	„ 2		
May Duke	„ 31	„ 22	„ 2		
Mount Pleasant	„ 31	„ 22	„ 2		
Red Warrington	„ 31	„ 22	„ 10		
Red Champagne	„ 31	„ 24	„ 15		
Victoria	„ 31	„ 27	„ 14		
Lancashire Lad	Apl. 1	Mar. 25	Mar. 13		
Golden Gem	„ 4	„ 23	„ 15		
Telegraph	„ 4	„ 25	„ 8		
Early Sulphur	„ 4	„ 25	„ 10		
Gretna Green	„ 4	„ 25	„ 12		
Blucher	„ 4	„ 25	„ 14		
Surprise	„ 4	„ 25	„ 21		
Falstaff	„ 4	„ 26	Apl. 15		
Ringer	„ 4	„ 26	„ 19		
Fascination	„ 4	„ 27	„ 17		
Dan's Mistake	„ 4	„ 30	„ 17		
Leader	„ 4	„ 30	„ 20		
Leveller	„ 8	Apl. 6	„ 16		
Faithful	„ 9	Mar. 26	„ 15		

Variety.	Date of Flowering.				
	1913	1912	1911	1910	1909
GOOSEBERRIES (*continued*).					
Hero of the Nile	Apl. 9	Mar. 27	Apl. 17		
Diadem	,, 9	,, 29	,, 16		
Transparent	,, 10	Apl. 5	,, 18		
High Sheriff	,, 12	Mar. 25	,, 8		
Careless	,, 12	,, 28	,, 14		
Thatcher	,, 12	Apl. 6	,, 18		
WHITE CURRANTS.					
White Versailles	Mar. 31	Apl. 27	Apl. 27		
White Dutch Cut Leaved	Apl. 4	,, 1	,, 25		
White Transparent	,, 4	,, 6	,, 22		
German White	,, 7	Mar. 27	,, 24		
White Dutch		Apl. 1	,, 22		
RED CURRANTS.					
Comet	Mar. 29	Mar. 27	Apl. 24		
Cherry	,, 31	,, 27	,, 23		
La Transparent	,, 31	,, 27	,, 27		
Fay's Prolific	Apl. 1	,, 21	,, 22		
Knight's Sweet Red	,, 2	,, 28	,, 23		
La Fertile	,, 4	,, 28	,, 24		
La Versailles	,, 4	,, 28	,, 23		
Wilder	,, 8	,, 28	,, 22		
La Hâtive	,, 8	Apl. 2	,, 29		
Red Cross	,, 10	,, 1	May 1		
Red Grape	,, 12	,, 11			
New Red Dutch	,, 12	,, 17	May 1		
Raby Castle	,, 19	,, 17	,, 7		
Wentworth Leviathan	,, 21	,, 5	,, 2		
Moore's Seedling	,, 21	,, 5			
Red American	May 1	,, 13			

THE INFLUENCE OF GRASS UPON THE GROWTH OF ORCHARD TREES.

By B. T. P. Barker.

In the Annual Reports for 1908, 1909 and 1911, reference has been made to experiments which have been in progress in the young cider orchard at the Institute to determine the value, if any, of the cultivation of a small circle around the base of each tree. Experiments at Woburn and elsewhere have already clearly demonstrated that grass has a prejudicial effect upon growth, and that, therefore, trees do better on cultivated than on grass land. Since, however, cider orchards are almost universally planted on grass, it was desired to ascertain if the removal of grass for a small area around each tree would suffice to lessen or prevent the injurious grass effect. In some cases the cultivated area extended for a radius of 4ft. 6in. around the tree, in others 3ft., and in the remainder the grass was allowed to grow to the base of the tree. In 1910 a limited number of the areas of 4ft. 6in. radius were extended to 6 feet.

The results of the experiments were quite definite up to 1910, six years after the planting of the trees, the larger the cultivated area the better being the growth. The gain by the trees in the cultivated areas was chiefly effected in the first three or four years after planting, and became less each year afterwards. It appeared, therefore, that the roots of the trees in the cultivated areas were beginning to extend beyond, and were thus beginning to feel the injurious grass effect. From 1910 to 1911 there was practically no gain, even in the special cases where the area was enlarged slightly in 1910. It was concluded at that stage that probably the limit of the beneficial effect of cultivation had been reached, and accordingly it was decided not to proceed further with cultivation but to allow the grass to grow up to the tree in all cases. The most recent measurements made in 1913 now show that in several cases there is a tendency for the trees which were grassed over from the start of the experiment to gain slightly on those originally kept in the cultivated areas: and the inference suggested is that the latter on being allowed to become grassed over are more susceptible and feel

the injurious grass effect, for the time being at any rate, all the more because of their freedom from it for so many years. If that proves ultimately to be correct, it is an important point, since it raises the whole question as to the length of time for which cultivation is going to be really profitable.

These conclusions are drawn mainly from the results of six varieties of trees. Several other varieties have also been included in the experiments: and they bear out generally the results of the former. For various reasons, however, which have interfered with the grassing trials to some extent, the results given by them are not included in the following statistics. The table appended gives the average results for the trees of the six sorts referred to, the size of the tree at the start of the experiment as indicated by its girth at a height of 5ft. 6in. above the ground being taken as 100 and the later figures showing the proportionate girth at the times specified.

Treatment of Tree	Average Girth				
	1906	1909	1910	1911	1913
Cultivated area 6ft. radius ..	100	—	—	273	324
Ditto 4ft. 6in. ..	100	199	242	277	326
Ditto 3ft.	100	180	219	255	303
Grass	100	166	196	232	284

Somewhat similar experiments are in progress in some of the demonstration orchards established in various parts of the West of England in conjunction with contributing County Councils. Most striking results have been obtained in an orchard planted on Mr. G. E. Lloyd Baker's estate, at Hardwicke, near Gloucester, in December, 1908. The cultivated area in this case was restricted to a circle of 2ft. radius. The measurements of the girths of the stems taken 4 feet from the ground were in the spring of 1913 as follows:—

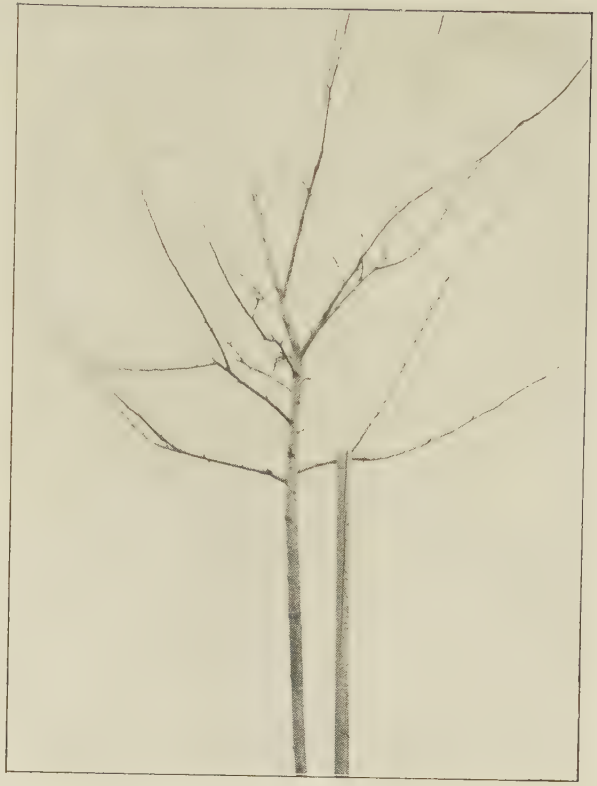
Variety	Girth of Stem	
	Tree grassed over	Tree in cultivated area
Royal Wilding	3½ inches	5½ inches
Medaille d'Or	3½ ,,	5¼ ,,
Strawberry Norman	3¾ ,,	5 ,,
Kingston Black	3¼ ,,	5¼ ,,
Sweet Alford	4¼ ,,	6½ ,,

The results in these cases are most markedly favourable to cultivation; and the accompanying photographs of some of the trees

show this very clearly, both as regards stem girth and also size of head. The staff shown in the photographs as a guide was four inches in girth. Mr. G. H. Hollingworth, F.R.H.S., Horticultural Instructor for Gloucestershire, has most kindly allowed the use of the photographs, and has furnished the particulars given. He has had the experiments in that county under his charge from the start.

None of the results at Long Ashton approached these as regards the extent of the difference between the grassed and ungrassed trees; and, indeed, the amount there fell considerably below expectations based on the Woburn experiments. The cause is not clear. Possibly the fact that at Long Ashton all the trees were cultivated for two years after planting before the experiments were started may have had something to do with it, by giving the trees grassed in 1906 a good start before the grass influence was brought into play. Certainly it is not due to specially favourable soil at Long Ashton, since Mr. Spencer Pickering has compared this with some of the Woburn soil in pot experiments and finds that it permits the injurious grass influence as badly as the latter.

SWEET ALFORD.
Cultivated round. Girth of stem, $6\frac{1}{2}$ inches.



SWEET ALFORD.
Grassed over. Girth of stem, $4\frac{1}{4}$ inches.

KINGSTON BLACK.
Cultivated round. Girth of stem, $5\frac{1}{4}$ inches.

KINGSTON BLACK.
Grassed over. Girth of stem, $3\frac{1}{4}$ inches.

ROYAL WILDING.
Cultivated round. Girth of stem, $5\frac{1}{2}$ inches.

ROYAL WILDING.
Grassed over. Girth of stem, $3\frac{1}{2}$ inches.

STOCK INFLUENCE UPON THE VINTAGE QUALITY AND OTHER CHARACTERS OF APPLES.

By B. T. P. Barker.

Reference has been made in each of the recent reports of the National Fruit and Cider Institute to the experimental work in progress on the influence of the root stock and intermediate stock from varieties of apples grafted thereon. The analyses of juices of a large number of varieties, worked both on the free stock and the Paradise stock have been given each year, but so far as the results have gone, no definite evidence has been forthcoming to show that the kind of root stock has had any appreciable influence upon the quality of the juice except that the rates of fermentation of juices obtained from fruit grown on the Paradise stock are in most cases higher than those from fruit grown on free stock.

The results concerned with root stock influence will be found in Table B of a preceding section of this Report.* In that table, unless otherwise stated, the root stock is of a free type. In the appended Tables C and D will be found the results of the analyses of the juices in the intermediate stock experiments.

In the case of the intermediate stock influence the results upon which any conclusions drawn are mainly based have been obtained from a number of trees in the Young Orchard at the Institute, which have been head-grafted with the Dabinett variety. In each case these trees have been worked on free stocks, and large a number of different intermediate stocks have been utilised. It has now been apparent for three or four years that in spite of comparatively wide differences between the juices of the fruit of individual trees in any one season, there is a marked tendency for the average composition for any individual tree to approach the same standard. It is not proposed here to enter into a detailed discussion on individual results, but the conclusion given in last year's report that the influence of the intermediate stock on vintage quality is very slight, even if it exists at all, is confirmed by the 1913 analyses.

* *Vide* The Composition of Vintage Apple and Pear Juices, 1913-14.

Experiments on intermediate stock influence on a rather more elaborate scale are also being conducted with bushes worked on the Paradise stock. The analyses of juices from these trees are given in Table D. Since these trees have only begun to fruit during the last two or three seasons it would be unwise to attempt to draw conclusions at the present stage. It will be seen from the table that the results especially as regards specific gravity vary considerably. As an extreme variation the cases of Kingston Black on White Bache and Court Royal as intermediate stocks may be quoted. The respective gravities being 1·076 and 1·046. Taking the results as a whole the acidities appear to be decidedly below the average for the varieties concerned. Thus Cap of Liberty on Silver Cup shows an acidity of ·47 per cent., whereas the normal acidity of the variety is from ·75 to ·9 per cent. Similarly Kingston Black on Footlands No. II shows an acidity of ·24 per cent. as against a normal acidity in the case of the Kingston Black variety of ·45 per cent. or higher. Further results are necessary before it can be decided if such abnormalities are due to the Paradise root stock influence or to the system under which intermediate stock influence is being tested in this series of experiments. The difference between this system and that under which the Dabinett trials above referred to are being conducted has been already briefly described on page 56 of the Annual Report of the Institute for 1912.

The whole of the analyses have been made this season by Mr. Grove. I am greatly indebted to him for this assistance and for the preparation of the tables.

TABLE C.—Composition of Dabinett Juices from Intermediate Stock Experiments.

Order of Tree in Row.	Composition of Juice, 1913.				Average Composition of Juice, 1908-13.			
	Specific Gravity.	Malic Acid, per cent.	Tannin, per cent.	Daily Fall in Specific Gravity at 27 deg. C.	Specific Gravity.	Malic Acid, per cent.	Tannin, per cent.	Daily Fall in Specific Gravity at 27 deg. C.
1. (Morgan Sweet)	1·064	·17	·38	5·3	—	—	—	—
2. (Broadleaf Jersey)	1·068	·13	·49	4·3	1·065	·13	·35	8·6
3. (King of the Pippins)	1·062	·15	·50	5·5	1·059	·17	·31	9·4
4. (Hardwicke)	1·072	·17	·58	4·5	1·063	·19	·38	9·6
5. (Warner's King)	1·069	·19	·44	6·6	1·063	·18	·32	8·7
6. (Bramley's Seedling)	1·064	·14	·40	4·8	1·061	·16	·38	8·7
7. (Ecklinville)	1·062	·13	·35	7·0	1·062	·16	·32	9·0
8. (Blenheim Orange)	1·060	·14	·27	6·0	1·059	·17	·35	7·6
9. (Annie Elizabeth)	1·063	·13	·40	4·8	1·063	·18	·35	7·9
10. (Newton Wonder)	1·059	·13	·36	5·5	—	—	—	—
11. (Peasgood's Nonsuch)	1·055	·14	·29	7·5	1·057	·19	·27	9·2
12. (Hollow Core)	1·058	·16	·35	5·6	1·061	·21	·33	8·3
13. (Sweet Alford)	1·059	·16	·31	5·7	—	—	—	—
14. (Broadleaf Norman)	1·059	·18	·38	5·0	1·058	·21	·31	7·6
15. (Court Royal)	1·059	·17	·34	4·6	1·060	·20	·32	7·1
16. (Ecklinville)	1·061	·19	·41	4·7	1·061	·21	·33	7·3
17. (Bramley's Seedling)	1·067	·18	·45	6·1	1·062	·20	·32	8·2
18. (Blenheim Orange)	1·059	·13	·28	6·3	1·062	·17	·33	—
19. (Warner's King)	1·054	·14	·29	7·6	—	—	—	—

TALLE C—*continued.*

Order of Tree in Row.	Composition of Juice, 1913.				Average Composition of Juice, 1908-13.			
	Specific Gravity.	Malic Acid, per cent.	Tannin, per cent.	Daily Fall in Specific Gravity at 27 Deg. C	Specific Gravity.	Malic Acid, per cent.	Tannin, per cent.	Daily Fall in Specific Gravity at 27 deg. C.
209. (Annie Elizabeth)	1·058	·14	·28	6·3	1·061	·18	·33	8·1
210. (Morgan Sweet)	1·056	·11	·29	5·1	1·060	·16	·35	5·0
211. (,, ,,)	1·056	·14	·33	5·4	1·060	·18	·32	5·6
212. (,, ,,)	1·060	·14	·36	6·0	1·062	·20	·32	6·2
213. (,, ,,)	1·056	·15	·31	5·6	1·062	·17	·35	6·6
214. (,, ,,)	1·057	·15	·34	6·4	1·061	·19	·33	6·9
215. (Newton Wonder)	1·058	·15	·30	7·0	1·066	·19	·34	—
216. (,, ,,)	1·061	·13	·31	4·8	1·063	·18	·34	—
217. (,, ,,)	1 062	·16	·35	4·1	1·060	·18	·27	—
191. (On Paradise Stock)	1·057	·09	·37	11·5	—	—	—	—
192. (,, ,,)	1·058	·08	·40	13·2	—	—	—	—
193. (,, ,,)	1·058	·12	·40	13·7	—	—	—	—
194. (,, ,,)	1·048	·09	·30	12·0	—	—	—	—

TABLE D.—Composition of Juices from Bushes on Paradise Root Stock & Intermediate Stock.

Name of Variety.	Intermediate Stock.	No.	Composition of Juice, 1913.			
			Specific Gravity.	Malic Acid, per cent.	Tannin per cent.	Rate of Fermentation.
Cap of Liberty	Broadleaf Norman ..	69	1·062	·64	·28	13·0
Ditto	Brown Jersey	75	1·050	·46	·30	11·2
Ditto	Ditto	77	1·049	·58	·30	10·2
Ditto	Cremière	435	1·053	·58	·21	8·3
Ditto	Cummy Norman ..	143	1·049	·50	·29	8·5
Ditto	Footlands, No. II. ..	102	1·050	·56	·23	10·5
Ditto	Ditto	103	1·048	·56	·24	9·5
Ditto	M. Jacques, No. II. ..	203	1·050	·56	·29	11·0
Ditto	Médaille d'Or	61	1·063	·68	·30	13·5
Ditto	Neverblight	244	1·049	·62	·21	10·7
Ditto	Royal Jersey	97	1·055	·58	·28	12·7
Ditto	Ditto	41	1·062	·64	·28	13·0
Ditto	Silver Cup	163	1·049	·47	·25	7·0
Dabinett	Ecarlatine	499	1·056	·07	·38	14·0
Ditto	Kingston Black Improved	266	1·062	·09	·49	9·8
Ditto	Ditto	267	1·059	·07	·39	11·0
Ditto	Redstreak	294	1·058	·10	·37	12·0
Ditto	Sharp's Summer ..	538	1·056	·08	·42	14·0
Ditto	Thomas Hunt	405	1·054	·08	·41	12·5
Ditto	White Styre	315	1·058	·07	·47	11·7
Ditto	Ditto	316	1·052	·07	·44	9·7
Kingston Black	Argile Grise	156	1·057	·32	·21	11·4
Ditto	Broadleaf Jersey ..	183	1·063	·40	·15	12·6

TABLE D—*continued.*

Name of Variety.	Intermediate Stock.	No.	Composition of Juices, 1913.			
			Specific Gravity.	Malic Acid, per cent.	Tannin, per cent.	Rate of Fermentation.
Kingston Black	Broadleaf Norman ..	68	1·075	·47	·18	13·6
Ditto	Brown Jersey	77	1·046	·29	·19	12·0
Ditto	Brown Thorn	160	1·063	·29	·16	12·6
Ditto	Cherry Pearmain ..	215	1·059	·30	·16	9·0
Ditto	Court Royal	342	1·046	·27	·20	6·2
Ditto	Doux Amer	360	1·062	·36	·15	17·3
Ditto	Eggleton Styre	224	1·065	·52	·14	7·8
Ditto	Footlands No. II. ..	102	1·047	·24	·20	8·8
Ditto	Ditto	106	1·057	·26	·20	8·8
Ditto	Harry Masters	138	1·058	·31	·20	8·2
Ditto	Improved Pound ..	285	1·050	·46	·20	3·5
Ditto	Knotted Kernel ..	24	1·065	·33	·15	13·0
Ditto	Ditto	28	1·054	·35	·20	10·8
Ditto	Médaille d'Or	63	1·068	·43	·18	13·6
Ditto	Reinette Obry	309	1·050	·34	·14	6·8
Ditto	Royal Jersey	100	1·057	·32	·15	10·8
Ditto	Royal Wilding	8	1·064	·33	·11	12·8
Ditto	Ditto	9	1·062	·34	·13	12·4
Ditto	Ditto	10	1·063	·36	·11	12·6
Ditto	Strawberry Norman ..	84	1·063	·29	·16	12·6
Ditto	White Bache	35	1·076	·59	·19	14·2
Ditto	Unknown	479	1·058	·40	·15	16·0
Ditto	Ditto	281	1·057	·37	·18	11·4
Sweet Alford	Cap of Liberty	251	1·049	·11	·11	9·8
Ditto	Knotted Kernel ..	28	1·052	·12	·11	10·0
Ditto	Médaille d'Or	58	1·057	·08	·12	9·4
Ditto	Neverblight	244	1·051	·10	·11	9·4

SOIL ANALYSIS.*

By C. T. Gimingham.

In the course of the year enquiries concerning soil problems have been received from the following localities:—Crowcombe, Wincanton, Long Ashton, Clutton, Ham Green, Brislington, Cheddar (Somerset), Redfield, Staple Hill, Fishponds, Clifton, Bradley Court (Gloucester), and Great Chalfield (Wilts). For the most part, these have been requests for advice as to the best system of manuring or as to the best method for removing some defect in the soil. Such questions as these invariably involve the analysis—partial or complete—of one or more samples of soil; and, instead of enumerating the enquiries in detail, it is proposed here to discuss more generally the practical value of soil analysis to the agriculturist and horticulturist, and to indicate some of the considerations which the analyst has to take into account in reporting on his results.

In the first place the fact has to be accepted that, owing partly to the still incomplete state of our knowledge of soils and partly to the lack of delicate analytical methods, we can only make practical use of the results of soil analysis within certain definite limits. Moreover, the problem submitted by the farmer is by no means so simple as it appears; and if information of real practical value is to be given, the investigation cannot be confined to straightforward analysis. Such factors as the rainfall, the situation, and the prevailing climate, will all affect the interpretation to be placed on the results. When, however, these points are borne in mind, much information of the greatest importance and value is to be obtained from the analysis of soils.

Of all the soil constituents, that which needs to be determined most frequently is carbonate of lime. The amount of this substance present varies enormously in different soils—from 40 to 50 per cent. in some chalk soils down to scarcely detectable amounts in some sands and peaty soils; and no hard-and-fast rule can be given

*This article is re-printed from the Journal of the Bath and West Society, 1913-14.

as to the percentage needful in each case. The presence of a sufficient quantity is, however, essential to fertility, for it is chiefly the action of lime, as a base, which maintains the neutrality of the soil. There are processes going forward in all soils causing the production of acid, and unless this acid is neutralised the soil will quickly become unproductive. Moreover, lime has an important physical effect in making heavy soils more open and easier to work; it also helps to bring the reserves of plant food material into a condition in which the crop can make use of them. For these and other reasons, a knowledge of the percentage of lime in his soil is of the greatest importance to the farmer, and fortunately very good methods are available for its determination. A great number of cases of poor pasture and unproductive arable land are due to nothing more obscure than a lack of lime.

Besides a sufficiency of lime, a fertile soil must provide a number of substances which the plant requires as food. Among these, only the nitrogen, phosphoric acid and potash need concern us, since almost all soils contain enough of the other plant foods. It is a comparatively easy matter, by chemical analysis, to determine the amount of these three substances present in any soil, but it often happens that the total amount of plant food thus determined is found to bear no relation whatever to the fertility of the soil. Any ordinary crop indeed utilises only a very small percentage of the total plant food present and the poorest soil usually contains enough for many crops. Evidently, therefore, only some part of the food material present at any time is in such a condition that plants can make use of it, and it becomes necessary to attempt to distinguish between the "total" plant food and that proportion of it which is "available." This can only be done by empirical methods which though giving results valuable in many cases still leave a good deal to be desired. The chemical analysis of soils is, indeed, of practical value in all ordinary cases only when the general composition of the type of soil to which the sample belongs is known. It does not help very much in the classification and grouping of soils.

The supply of food to the plant is, however, only one of the factors which goes to make up the fertility of the soil. The physical properties (texture) are often of greater importance, for these not only determine whether a soil is easy or difficult to work, but also whether it will supply the crop with sufficient water in a time of drought, and whether it will get rid of surplus water in a time of heavy rainfall. Now these properties depend on the proportions in which the various sizes of particles composing the soil are mixed, and on the extent to which the finer grades are aggregated into compound particles. Those soils in which the finest particles predominate are clays, soils with much coarse material are sands, whilst intermediate types are loams. By means of what is

known as mechanical analysis the proportions of the various grades of particles can be estimated, and if to this is added a determination of the percentage of carbonate of lime and of organic matter (since these two soil constituents have a most important influence on the extent to which compound particles are formed) a very good picture of the physical structure of the soil is obtained.

It is found that over very large areas of country the type of soil is determined by the nature of the underlying rock (from which it has been formed by weathering) even though the local variations may be considerable. Where, however, large disturbances have taken place, such as the occurrence of a glacial period, this no longer holds, the original surface often having been washed away or concealed by a deposit of drift. Even on one geological formation, the lithological characters may vary considerably in passing along the formation, in which case the derived soils will vary correspondingly. Nevertheless, on the whole it may be said that each type of soil shows a fairly constant texture and composition within its own area, the boundaries of which may be approximately defined; and the geological formations can be used as the basis for the study of soils, so long as account is taken of the presence of drift deposits, etc.

The chief value of mechanical analysis lies, then, in the means which it gives of grouping soils into certain definite types, and of correlating the properties of the various types with the methods of farming to which they are found to be most suited. It is therefore evident that in order to be able to interpret the results of analysis of any given soil to the best advantage a knowledge of the composition and properties of the type to which it belongs is needed. Hence the paramount importance of systematic soil surveys which aim at defining the distribution of soil types and which, while providing material for comparison with the results of isolated analyses, also help to indicate the characteristics which determine the suitability of soils for particular crops. When the average composition of the type to which a sample belongs is known, it is possible from the results of analysis to ascertain whether it is in any way abnormal and whether any observed defects are inherent in the soil or are due to the methods of farming. Further, the best crops to grow, and the best system of manuring, may be indicated with some approach to accuracy. It is important to remember, however, that the results of mechanical analysis have always to be considered with reference to the amount of organic matter and of carbonate of lime present; and, also, with reference to the rainfall of the district, the nature of the subsoil and the situation, especially as it affects the supply of underground water.

The discussion of an actual example will, perhaps, make these points clearer.

UNIVERSITY OF BRISTOL RESEARCH STATION SOILS.

	1 Pasture	2 Pasture	3 Arable	4 Arable	5 Arable
MECHANICAL ANALYSIS	%	%	%	%	%
Surface Soil.					
Fine Gravel	0·73	0·70	0·82	0·94	1·04
Coarse Sand	19·36	10·85	10·55	9·61	11·04
Fine Sand	35·16	42·55	40·86	34·96	38·51
Silt	11·46	14·00	13·18	14·34	13·52
Fine Silt	16·50	15·20	18·82	21·21	18·46
Clay	5·10	6·67	7·16	10·16	9·25
Subsoil.					
Fine Gravel	1·00	1·05			0·25
Coarse Sand ..	17·21	11·87			6·46
Fine Sand	39·44	45·18			31·84
Silt	11·97	16·75			13·35
Fine Silt	15·42	10·65			22·21
Clay	9·75	9·61			18·02
CHEMICAL ANALYSIS.					
Surface Soil.					
Moisture	2·4	2·4	1·83	2·48	1·92
Organic Matter ..	8·18	7·31	5·53	5·61	5·35
Carbonate of Lime ..	0·43	0·02	0·07	0·35	0·22
Phosphoric Acid (total)	—	0·16	0·15	0·13	0·12
Ditto ditto (available)	0·036	—	0·026	0·029	0·024
Potash (total) ..	—	0·67	0·82	0·87	0·75
Ditto (available)	0·032	—	0·034	0·035	0·033
Subsoil.					
Moisture	1·44	1·40			2·02
Organic Matter ..	3·25	2·60			3·07
Carbonate of Lime ..	0·22	0·26			1·23

In the accompanying Table will be found the analyses of some of the soils of the University Research Station at Long Ashton. These are situated on and derived from the New Red Sandstone formation (Keuper Marl). A glance at the mechanical analyses* of the surface soils shows at once that all belong to the same type characterised by a high proportion of "fine sand" and a high ratio of "fine silt" to "clay." There are certain minor differences, but these are not of importance for our present purpose.

A small number of analyses such as these do not, of course, by any means define a soil type; but if we accept these for illustration, as typical of an area of Keuper Marl soils, we will suppose that a sample of soil belonging to this group, and taken from a field which does not produce average crops, has been sent for analysis.

* The terms Fine Gravel, Coarse Sand, etc., indicate separate fractions of the soil, each composed of particles falling within certain arbitrarily chosen limits of size, "fine gravel" being the coarsest and "clay" the finest.

If the soil and subsoil of the field prove to be in all respects normal and precisely like the type, it becomes necessary to look elsewhere than to the mechanical and chemical composition for an explanation of the unusually low fertility. The rainfall may have an influence. A very high rainfall brings into special prominence the "clayey" properties of the finer grades of particles, and the soil will behave like a much heavier soil under lower rainfall. Special attention would then have to be given to drainage and the rapid removal of surplus water. On the other hand the situation may be such that the supply of underground water is insufficient and the rainfall low. The most important property of the soil will then be its power of lifting the subsoil water, and something can, perhaps, be done by special methods of cultivation to increase the power of the soil in this respect and to conserve the surface water. The nature of the subsoil will also influence the supply of water to the crop and may be the cause of under or over drainage. An injudicious system of manuring, or other mistakes in management or cultivation, may also account for lowered fertility.

The analysis may, on the other hand, indicate a deviation from the type in some particular; and it may or may not be possible to correct this. The amount of potash, perhaps, may be below the average, and, although the quantity present would be amply sufficient in another kind of soil, yet by comparison with the typical samples the inference can be drawn that potash manuring will probably be valuable. Again, a lack of carbonate of lime may be responsible for many defects. Finally, should there be a marked variation from the type in the mechanical composition of the sample, it may be possible in some cases to get better results by a change in the system of cropping.

In some such ways as these the information given by the results of soil analyses may be of considerable practical value; and the further the work of soil surveys is carried, the more detailed and the more valuable will the available information become.

ADVISORY WORK.

Reference was made in the Report of last year to the scheme organised by the Board of Agriculture and Fisheries for the provision of technical advice and assistance to farmers, in connection with the various local problems in agriculture with which they have to contend: and it was stated that this Department had been appointed to serve under the scheme as an Advisory Centre for the counties of Gloucester, Hereford, Somerset, Wiltshire and Worcester. During the past year the scheme has been in operation and many enquiries have been received. There appears to have been some doubt among several of those wishing to avail themselves of the facilities offered, as to the procedure necessary to obtain assistance. On that account it may be pointed out here that the correct course in the first instance is to communicate with the Director of Agricultural Education for the county in which the applicant resides. If the matter is one that can suitably be dealt with by the Staff of the County Agricultural Education Department, the latter will take action directly: but if the question is one requiring reference to the Advisory Centre, it will be forwarded there for further treatment.

It may be of interest to indicate briefly the kind of work which has arisen during the past year; and the following summary will suffice to show the varied nature of the enquiries, some of which could be dealt with without experiment, while others required further examination and in some cases are still under investigation. In addition to those mentioned numerous enquiries have also been received on matters relating to fruit culture and cider making.

The Action of various Lime Washes as Winter Sprays for Fruit Trees.—This work was undertaken at the request of certain of the Instructors in Horticulture of the counties included in the Bristol Province, who reported considerable discrepancy in the results of local demonstrations with these spray fluids as given by them in previous years.

Comparative trials of various types of these washes were carried out at two centres in each of the following counties:—Gloucester, Hereford, Somerset and Wiltshire, and three centres in Devon. The latter county, although outside the Bristol province, was

included in the scheme on account of its association with the Institute. The trials were made under the personal direction and supervision of Mr. A. H. Lees, the Adviser in Plant Pathology, the local arrangements being made by the Instructors in Horticulture for the counties concerned. At the same time duplicate trials were conducted at Long Ashton. The Adviser has since visited as required all the orchards and plantations included in the scheme to make the necessary observations as to the results of the tests. These experiments need extension under somewhat different conditions next season before satisfactory conclusions can be drawn.

The Flesh-Colour of Rhode Island Red Fowls.—This investigation was undertaken at the request of the Board of Agriculture and Fisheries. It was alleged that the flesh-colour of this breed, which is normally yellow, invariably came white in the case of birds reared at one of the poultry farms in Gloucestershire, while, when eggs obtained from that place were hatched elsewhere, the flesh of the birds reverted to the normal yellow tint. The market value of the white-fleshed birds is stated to be considerably higher than that of the yellow-fleshed type, and information as to the cause of the change in flesh-colour was therefore sought. After verification, in the main, of the alleged facts, experiments were begun at Long Ashton, and for a short time also at the farm in question. The tenant, however, left the latter last May, and since that time the work has been confined to Long Ashton, which has hampered considerably the investigation in the direction as to the effect of local conditions. Several interesting facts have already been brought to light. Experiments are still in progress, the results of which are not yet available.

Eelworm Disease of Strawberries.—Strawberry growers in the Cheddar district of Somerset have reported a serious outbreak of disease in their plantations, which has been found to be caused by eelworms. During the past summer experiments for remedial treatment have been carried on, and these are still in progress.

Diseases of Plants.—Several cases of diseased plants have been submitted for examination, and as far as possible advice for treatment has been given. Among them may be mentioned leaf-curl of Almond and Peach foliage caused by *Exoascus deformans*, the dying back of spurs of apple trees and the shoots of Plum trees due to *Sclerotinia fructigena*, the dying off of Plum trees due to *Eutypella prunastri* and *Stereum purpureum*, blindness of strawberry blossom resulting from the decay of the stamens owing to attack by *Botrytis sp.*, the dying off of Cherry trees caused by *Armillaria mellea*, and the damping off of Tomato plants due in part to *Pythium de Baryanum* and in part to a cause not yet ascertained. A case of chlorosis of Potato foliage was sent in, and this is still under investigation, as is the case also with an outbreak of Clover Sickness.

Several instances of damage caused by insect pests were also referred including a disease of Celery Stems due to the Celery Stem Fly, and the dying back of a hedge of Thuja macrocarpa, caused by an attack of *Lachinella thuja*. It is believed that this is the first reported occurrence of this insect in Britain.

Miscellaneous.—Among questions of a miscellaneous character may be mentioned the poisoning of cattle due to eating foliage of a species of Thuja ; the relation of the occurrence of Spiney Rest-Harrow in pastures to the lime content of the soil ; kainite and lime treatment for parasitic worms in pasture land ; an analytical examination of glove clippings, with a view to their value for agricultural purposes ; and the decay of Algae in reservoirs.